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PUBLIC DATA NETWORKS:
TRANSMISSION, SIGNALLING
AND SWITCHING

PACKET-SWITCHED SIGNALLING SYSTEM BETWEEN PUBLIC NETWORKS PROVIDING DATA TRANSMISSION SERVICES

ITU-T Recommendation X.75

(Previously "CCITT Recommendation")

FOREWORD

The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the International Telecommunication Union. The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation X.75 was revised by the ITU-T Study Group VII (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

In order not to delay publication of this Recommendation, no change has been made in the text to references containing the acronyms "CCITT, CCIR or IFRB" or their associated entities such as Plenary Assembly, Secretariat, etc. Future editions of this Recommendation will contain the proper terminology related to the new ITU structure.

2 In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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(Provisional, Geneva, 1978; amended at Geneva, 1980, Malaga-Torremolinos, 1984, Melbourne, 1988, and Helsinki, 1993)

The establishment in various countries of public networks providing packet-switched data transmission services (creates a need to standardize international interworking.

The CCITT,

considering

(a) that Recommendation X.1 includes specific user classes of service for data terminal equipments operating in the packet mode, Recommendation X.2 defines user facilities, Recommendations X.25, X.28, X.29, X.31 and X.32 define DTE/DCE interface characteristics and Recommendation X.96 defines call progress signals;

(b) that the logical links A1 and G1 in an international connection are defined in Recommendation X.92 for packet-switched data transmission services;

(c) that Recommendations X.300, X.301 and X.302 define the general principles and arrangements for interworking between public data networks, and between public data networks and other public networks;

(d) that Recommendations X.320, X.322, X.323 and X.325 provide descriptions of interworking cases among networks;

(e) that Recommendation X.180 defines the administrative arrangements for Intentional Closed User Groups and that Recommendation X.181 defines the administrative arrangements for the provision of international Permanent Virtual Circuits;

(f) that the necessary elements of the signalling terminal (STE) interface Recommendation at the gateway/transit data switching exchange should be defined independently as:

Physical layer – the mechanical, electrical, functional and procedural characteristics to activate, maintain and deactivate the physical link at the signalling terminal interface;

Link layer – the link layer procedures for data interchange across the interface between the signalling terminals;

Packet layer – the packet format and signalling procedures for the exchange of packets containing control information and user data at the signalling terminal interface;

(g) that Recommendations X.134, X.135, X.136 and X.137 define the quality of service parameters in public networks providing packet-switched data transmission services;

(h) that Recommendations X.110, X.121, E.164 and E.166/X.122 describe the routing principles and numbering plans for public networks including ISDNS;

unanimously declares

1) that the basic system structure of the signalling and data transfer procedures in terms of elements, should be as specified in the Introduction: *Basic system structure;*

2) that the mechanical, electrical, functional and procedural characteristics to activate, maintain and deactivate the physical link at the signalling terminal interface should be as specified in clause 1: *Physical layer – Characteristics of the signalling terminal/physical circuit interface;*

3) that the link layer procedures which operate over the physical circuits and provide a mechanism for reliable transport of packets at the signalling terminal interface should be as specified in clause 2: *Link layer procedures between signalling terminals;*

4) that the packet signalling procedures for the exchange of call information and user data at the signalling terminal interface should be as specified in clause 3 below: *Packet layer procedures between signalling terminals;*

5) that the packet format for packets exchanged at the signalling terminal interface should be as specified in clause 4 below: *Packet formats for virtual calls and permanent virtual circuits;*

6) that the procedure and formats for user facilities and network utilities at the signalling terminal interface should be as specified in clause 5: *Procedure and formats for user facilities and network utilities.*

0 Introduction

0.1 General

This Recommendation defines the characteristics and operation of a signalling system for use on interconnecting links between various types of public networks to provide internetwork data transmission services. It permits the transfer of call control and network control information and user traffic.

The Recommendation applies to all links between packet-switched public data networks in different countries and also in a number of cases of international links with ISDNs as specified in Recommendation X.300. These include links between ISDNs and packet-switched public data networks and links between ISDNs providing packet-switched data transmission services as defined in Recommendation X.31. It may also be used on such links where the two public networks are in the same country.

Each internetwork link comprises two directly connected signalling terminals (STEs) each within a public network. Transmission facilities between the two STEs may comprise either one or a number of circuits. Each STE is associated with one end of one link and is part of an exchange or exchange function in the public network.

Certain parts of this Recommendation apply in only a limited range of interworking situations; these are clearly indicated in the text. Some concern links between public networks in the same country, and others concern links where at least one public network is not a packet-switched data network.

The protocol elements included in this Recommendation can be used to support the Network Layer Service for interworking situations.

0.2 Elements

The system is made up of communicating elements which function independently and are therefore defined separately. These elements are:

a) the physical circuits which comprise transmission facilities, and a set of mechanical, electrical functional and procedural interface characteristics between the transmission facilities and the signalling terminals and which provide a mechanism for information transfer between two signalling terminals;

b) the link layer procedures which operate over the physical circuits and provide a mechanism for reliable transport of packets between the two signalling terminals independently of the particular types of physical circuit in use;

c) the packet layer procedures which use the link layer procedures and provide a mechanism for the exchange of call control information and user traffic between the two signalling terminals.

0.3 Basic system structure

The basic system structure of the signalling procedures, in terms of the elements, is shown in Figure 1.

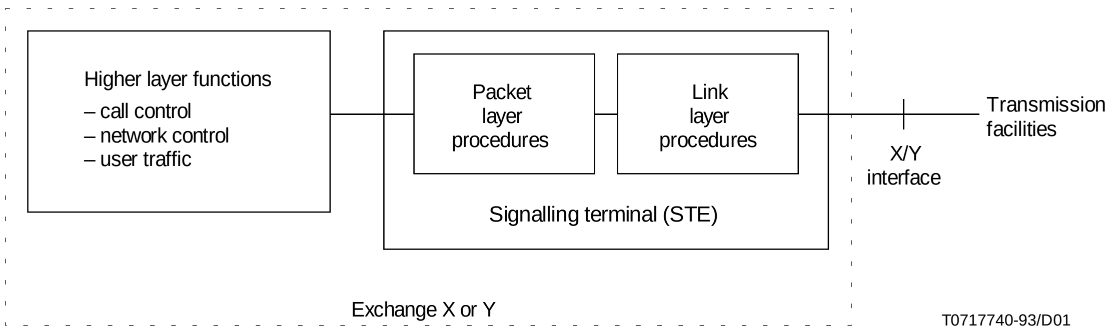


FIGURE 1/X.75

Basic system structure of signalling procedures

NOTE – Applicable to this Recommendation:

a) STE-X denotes the STE of the exchange under consideration on the link concerned;

b) STE-Y denotes the STE of the other exchange under consideration on the link;

c) The STE-X/STE-Y interface is abbreviated to the X/Y interface;

d) Multiple X/Y interfaces may be used between two networks. In this case, each X/Y interface behaves according to the physical, link and packet layer formats and procedures within this Recommendation.

1 Physical layer – Characteristics of the signalling terminal/physical circuit interface

The characteristics of the signalling terminal/physical circuit interface, defined as the physical layer element, shall be in accordance with Recommendation G.703, for physical circuits having a bearer rate of 64 kbit/s and optionally, by bilateral agreement, 2 Mbit/s.

For 2 Mbit/s, the frame structure conforms to Recommendation G.704. Time slot 0 will be used for the detection of faults (G.732), the indication of alarms, and for maintenance facilities (loop backs). Time slot 16 is not used in order to have the same structure as an H 12 channel. The remaining 30 time slots should be used as one single bit stream of 1920 kbit/s. Further information is given in Appendix II.

In addition, Administrations may use for digital circuits any other recognized rate (e.g. 1.544 Mbit/s, *n* times 64 kbit/s channels) by bilateral agreement.

However, for an interim period by bilateral agreement, any other recognized rates could be used for analogue circuits, in which case the characteristics of the signalling terminal/physical circuit interface shall be in accordance with the appropriate V-Series Recommendations.

Each physical circuit of the link must be capable of supporting duplex operation.

In the case of international interworking between packet-switched public data networks, the link is assumed to be data link Al and/or data link GI in terms of the hypothetical reference connections defined in Recommendation X.92.

2 Link layer procedures between signalling terminals

2.1 Scope and field of application

2.1.1 In order to provide a mechanism for the reliable transport of packets between two signalling terminals, it is necessary to define a procedure which can accept and deliver packets to the packet layer when either single or multiple physical circuits are employed. A multiplicity of physical circuits is required if the effects of circuit failures are not to disrupt the packet layer operation.

2.1.2 The Single link procedure (SLP) described in 2.2 to 2.4 is used for data interchange over a single physical circuit, conforming to the description given in 1, between two STEs. When multiple physical circuits are employed in parallel this single link procedure is used independently on each circuit and the Multilink procedure (MLP) described in 2.5 may be used for data interchange over these multiple parallel links. In addition, when only a single physical circuit is employed, Administrations may agree bilaterally to use this multilink procedure over the one link.

2.1.3 Each transmission facility is duplex.

2.1.4 The single link procedure is based upon the Link access procedure (LAPB) described in 2/X.25. The procedure uses the principle and terminology of the High level data link control (HDLC) procedure specified by the International Organisation for Standardisation (ISO).

The multilink procedure is based on the principle and terminology of the multilink procedure specified by ISO.

2.1.5 For each SLP employed, either extended mode (modulo 128) or non-extended mode (modulo 8) may be used. The choice of the mode employed for such link procedures is independent of all others and of the choice of mode for the corresponding packet layer procedures. All choices are matters for bilateral agreement.

NOTE – Appendix III provides guidelines for transmission over channels with long round-trip delay and/or transmission rates higher than 64 kbit/s.

2.2 Frame structure

2.2.1 All transmissions are in frames conforming to one of the formats of Tables 1 and 2. The flag preceding the address field is defined as the opening flag. The flag following the Frame checking sequence (FCS) field is defined as the closing flag.

TABLE 1/X.75

Frame formats (modulo 8)

Bit order of transmission	12345678	12345678	1 to 8	16 to 1	12345678
	Flag	Address	Control	FCS	Flag
	F 01111110	A 8 bits	C 8 bits	FCS 16 bits	F 01111110

Bit order of transmission	12345678	12345678	1 to 8		16 to 1	12345678
	Flag	Address	Control	Information	FCS	Flag
	F 01111110	A 8 bits	C 8 bits	I N bits	FCS 16 bits	F 01111110

FCS Frame checking sequence
$0 \le N \le N1 - 32$

TABLE 2/X.75

Frame formats (modulo 128)

Bit order of transmission	12345678	12345678	1 to [a)]	16 to 1	12345678
	Flag	Address	Control	FCS	Flag
	F 01111110	A 8 bits	C bits [a)]	FCS 16 bits	F 01111110

Bit order of transmission	12345678	12345678	1 to [a)]		16 to 1	12345678
	Flag	Address	Control	Information	FCS	Flag
	F 01111110	A 8 bits	C bits [a)]	I N bits	FCS 16 bits	F 01111110

FCS Frame checking sequence
$0 \le N \le N1 - 40$

a) Sixteen bits for frame formats that contain sequence numbers; 8 bits for frame formats that do not contain sequence numbers (see Note).

NOTE – For an interim period, frames that do not contain sequence numbers may alternatively have a 16-bit control field format as described in 2.3.2.1.3.

2.2.2 Flag sequence

All frames shall start and end with the flag sequence consisting of one 0 bit followed by six contiguous 1 bits and one 0 bit. The STE shall only send complete and distinct eight-bit flag sequences when sending multiple flag sequences (see 2.2.1 1). A single flag may be used as both the closing flag for one frame and the opening flag for the next frame.

2.2.3 Address field

The address field shall consist of one octet. The address field identifies the intended receiver of a command frame and the transmitter of a response frame. The coding of the address field is described in 2.4.2.

2.2.4 Control field

The control field shall consist of one or two octets. The content of this field is described in 2.3.2.

2.2.5 Information field

The information field of a frame, when present, follows the control field (see 2.2.4) and precedes the frame check sequence (see 2.2.7). See 2.3.4.9, 2.5.2 and 4 for the various codings and groupings of bits in the information field as used in this Recommendation.

See 2.3.4.9 and 2.4.8.5 with regard to the maximum information field length.

2.2.6 Transparency

The STE, when transmitting, shall examine the frame content between the two flag sequences including the address, control, information and FCS fields and shall insert a 0 bit after all sequences of five contiguous I bits (including the last five bits of the FCS) to ensure that a flag sequence is not simulated. The STE, when receiving, shall examine the frame content and shall discard any 0 bit which directly follows five contiguous 1 bits.

2.2.7 Frame checking sequence (FCS) field

The notation used to describe the FCS is based on the property of cyclic codes that a code vector such as 1000000100001 can be represented by a polynomial $P(x) = x^{12} + x^5 + 1$. The elements of an n element code word are thus the coefficients of a polynomial of order $n – 1$. In this application, these coefficients can have the value 0 or 1 and the polynomial operations are performed modulo 2. The polynomial representing the content of a frame is generated using the first bit received after the frame opening flag as the coefficient of the highest order term.

The FCS field shall be a 16-bit sequence. It shall be the ones complement of the sum (modulo 2) of:

1) the remainder of $x^k (x^{15} + x^{14} + x^{13} + x^{12} + x^{11} + x^{10} + x^9 + x^8 + x^7 + x^6 + x^5 + x^4 + x^3 + x^2 + x + 1)$ divided (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$ where k is the number of bits in the frame existing between, but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency; and

2) the remainder of the division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$ of the product of x^{16} by the content of the frame existing between, but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency.

As a typical implementation, at the transmitter, the initial content of the register of the device computing the remainder of the division is preset to all 1s and is then modified by the division by the generator polynomial (as described above) on the address, control and information fields; the ones complement of the resulting remainder is transmitted as the 16-bit FCS.

As the receiver, the initial content of the register of the device computing the remainder is preset to all 1s. The final remainder, after multiplication by x^{16} and then division (modulo 2) by the generator polynomial $x^{16} +x^{12} + x^5 + 1$ of the serial incoming protected bits and FCS, will be 0001110100001111 (x^{15} through x^0, respectively) in the absence of transmission errors.

NOTE – Explanatory examples are given in Appendix I/X.25.

2.2.8 Order of bit transmission

Addresses, commands, responses and sequence numbers shall be transmitted with the low order bit first (for example, the first bit of the sequence number that is transmitted shall have the weight 2).

The order of transmitting bits within the information field is not specified under 2. The FCS shall be transmitted to the line commencing with the coefficient of the highest term, which is found in bit position 16 of the FCS field (see Tables 1 and 2).

NOTE – In Tables 3, 4, 5, 6, 7, 8 and 10, bit 1 is defined as the low order bit.

2.2.9 Invalid frames

The definition of an invalid frame is described in 2.3.5.3.

2.2.10 Frame abortion

Aborting a frame is performed by transmitting at least seven contiguous 1s (with no inserted 0s).

2.2.11 Interframe time fill

Interframe time fill is accomplished by transmitting contiguous flags between frames, i.e., multiple eight-bit flag sequences (see 2.2.2).

2.2.12 Link channel states

A link channel as defined here is the means for transmission for one direction.

2.2.12.1 Active channel state

The incoming or outgoing channel is defined to be in an active condition when it is receiving or transmitting respectively, a frame, an abortion sequence or inter frame time fill.

2.2.12.2 Idle channel state

The incoming or outgoing channel is defined to be in an idle condition when it is receiving or transmitting, respectively, a contiguous 1 state for a period of at least 15 bit times.

See 2.3.5.5 for a description of STE action when an idle condition exists on its incoming channel for an excessive period of time.

2.3 Elements of procedures

2.3.1 The elements of procedures are defined in terms of actions that occur on receipt of frames.

A procedure is derived from these elements of procedures and is described in 2.4. Together, 2.2 and 2.3 form the general requirements for the proper management of the link.

2.3.2 Control field formats and parameters

2.3.2.1 Control field formats

The control field contains a command or a response, and sequence numbers where applicable.

Three types of control field formats (see Tables 3 and 4) are used to perform numbered information transfer (I format), numbered supervisory functions (S format) and unnumbered control functions (U format).

TABLE 3/X.75

Control field formats (modulo 8)

Control field bits	1	2	3	4	5	6	7	8
I format	0	N(S)			P	N(R)		
S format	1	0	S	S	P/F	N(R)		
U format	1	1	M	M	P/F	M	M	M

N(S) Transmitter send sequence number (bit 2 = low-order bit).

N(R) Transmitter receive sequence number (bit 6 = low-order bit).

S Supervisory function bit.

M Modifier function bit.

P/F Poll bit when issued as a command, final bit when issued as a response (1 = Poll/Final).

P Poll bit (1 = Poll).

TABLE 4/X.75

a) Control field formats (modulo 128)

Control field bits	1st octet								2nd octet							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I format	0	N(S)							P	N(R)						
S format	1	0	S	S	X	X	X	X	P/F	N(R)						
U format	1	1	M	M	P/F	M	M	M								

b) Alternative U format; control field formats (modulo 128) (See Note)

Control field bits	1st octet								2nd octet							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
U format	1	1	M	M	U	M	M	M	P/F	X	X	X	X	X	X	X

N(S) Transmitter send sequence number (bit 2 = low-order bit)

N(R) Transmitter receive sequence number (bit 10 = low-order bit)

S Supervisory function bit

M Modifier function bit

X Reserved and set to 0

U Unspecified

P/F Poll bit when issued as a command, final bit when issued as a response (1 = Poll/Final)

P Poll bit (1 = Poll)

NOTE – For an interim period, as described in 2.3.2.1.3, Administrations may bilaterally agree to use an unnumbered format that consists of a 2-octet control field.

2.3.2.1.1 Information transfer format – I

The I format is used to perform an information transfer. The functions of N(S), N(R) and P/F independent: i.e., each I frame has a N(S), a N(R) which may or may not acknowledge additional I frame received by the STE, and a P bit.

2.3.2.1.2 Supervisory format – S

The S format is used to perform link supervisory control functions such as acknowledge I frames, request transmission of I frames, and to request a temporary suspension of transmission of I frames. The function of N(R) and P/F are independent; i.e., each supervisory frame has an N(R) which may or may not acknowledge additional I frames received by the STE, and a P/F bit that may be set to 0 or 1.

2.3.2.1.3 Unnumbered format – U

The U format is used to provide additional link control functions. This format contains no sequence number but does include a P/F bit that may be set to 0 to 1. The encoding of the unnumbered commands and responses is as defined in Tables 5 and 6. Unnumbered U frames make use of a single octet control field for both modulo 8 and extended modulo 128 operations. However, for an interim period and for extended modulo 128 operations only, some Administrations may choose after bilateral agreement, the 2 octet control field coding described in **b)** of Table 6.

2.3.2.2 Control field parameters

The various parameters associated with the control field formats are described below.

2.3.2.2.1 Modulus

Each I frame is sequentially numbered and may have the value 0 through modulus minus 1 (where “modulus” is the modulus of the sequence numbers). The modulus equals 8 or 128 and the sequence numbers cycle through the entire range.

2.3.2.2.2 Send state variable V(S)

The send state variable denotes the sequence number of the next in-sequence I frame to be transmitted. The send state variable can take on the value 0 through modulus minus 1. The value of the send state variable is incremented by 1 with each successive I frame transmission, but cannot exceed N(R) of the last received I or S format frame by more than the maximum number of outstanding I frames (*k*). The value of *k* is defined in 2.4.8.6.

2.3.2.2.3 Send sequence number N(S)

Only I frames contain N(S), the send sequence number of transmitted frames. At the time of an in-sequence I frame is designated for transmission, the value of N(S) is set equal to the value of the send state variable.

2.3.2.2.4 Receive state variable V(R)

The receive state variable denotes the sequence number of the next in-sequence I frame expected to be received. This receive state variable can take on the values 0 through modulus minus 1. The value of the receive state variable is incremented by I by the receipt of an error free, in-sequence I frame whose send sequence number N(S) equals the receive state variable.

2.3.2.2.5 Receive sequence number N(R)

All I frames and supervisory frames contain N(R), the expected send sequence number of the next received I frame. At the time that a frame of the above types is designated for transmission, the value of N(R) is set equal to the current value of the receive state variable. N(R) indicates that the STE transmitting the N(R) has received correctly all I frames numbered up to and including [N(R) – 1].

2.3.2.2.6 Poll/Final (P/F) bit

All frames contain P/F the Poll/Final bit. In command frames the P/F bit is referred to as the P bit. In response frames it is referred to as the F bit.

2.3.3 Functions of the Poll/Final bit

The Poll bit set to 1 is used by the STE to solicit (poll) a response from the other STE. The Final bit set to 1 is used by the STE to indicate the response frame transmitted by the other STE as a result of the soliciting (poll) command.

The use of the P/F bit is described in 2.4.3.

2.3.4 Commands and responses

The following commands and responses will be supported by the STE and are represented in Tables 5 and 6.

The supervisory function bit encoding 11, and those encodings of the modifier function bits in Tables 3 and 4 not identified in Tables 5 and 6, are identified as undefined or not implemented command and response control fields.

The commands and responses are as follows:

2.3.4.1 Information (I) command

The function of the information (I) command is to transfer across a data link sequentially numbered frames containing an information field.

2.3.4.2 Receive ready (RR) command and response

The Receive ready (RR) supervisory frame is used by the STE to:

1) indicate it is ready to receive an I frame;

2) acknowledge previously received I frames numbered up to and including [N(R) – 1].

An RR frame may be used to indicate the clearance of a busy condition that was reported by the earlier transmission of an RNR frame by that same STE. In addition to indicating the STE status, the RR command with the P bit set to 1 may be used by an STE to ask for the status of the other STE.

TABLE 5/X.75

Commands and responses (modulo 8)

Format	Command	Response	Encoding 1	2	3	4	5	6	7	8
Information transfer	I (information)		0	N(S)			P	N(R)		
Supervisory	RR (receive ready	RR (receive ready)	1	0	0	0	P/F	N(R)		
	RNR (receive not ready)	RNR (receive not ready)	1	0	1	0	P/F	N(R)		
	REJ (reject)	REJ (reject)	1	0	0	1	P/F	N(R)		
Unnumbered	SABM (set asynchronous balanced mode)		1	1	1	1	P	1	0	0
	DISC (disconnect)		1	1	0	0	P	0	1	0
		FRMR (frame reject)	1	1	1	0	F	0	0	1
		UA (unnumbered acknowledgement)	1	1	0	0	F	1	1	0
		DM (disconnected mode)	1	1	1	1	F	0	0	0

TABLE 6/X.75

a) Commands and responses (modulo 128)

Format	Command	Response	1	2	3	4	5	6	7	8	9	10 to 16
			Encoding									
Information transfer	I (information)		0	N(S)							P	N(R)
Supervision	RR (receive ready)	RR (receive ready)	1	0	0	0	0	0	0	0	P/F	N(R)
	RNR (receive not ready)	RNR (receive not ready)	1	0	1	0	0	0	0	0	P/F	N(R)
	REJ (reject)	REJ (reject)	1	0	0	1	0	0	0	0	P/F	N(R)
Un-numbered	SABME (set asynchronous balanced mode extended)		1	1	1	1	P	1	1	0		
	DISC (disconnect)		1	1	0	0	P	0	1	0		
		FRMR (frame reject)	1	1	1	0	F	0	0	1		
		UA (un-numbered acknow-ledgement)	1	1	0	0	F	1	1	0		
		DM (disconnected mode)	1	1	1	1	F	0	0	0		

b) Alternative unnumbered commands and responses (modulo 128) (see Note 2)

Format	Command	Response	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
			Encoding (Note 1)															
Unnumbered	SABME (set asynchronous balanced mode extended)		1	1	1	1	U	1	1	0	P	0	0	0	0	0	0	0
	DISC (disconnect)		1	1	0	0	U	0	1	0	P	0	0	0	0	0	0	0
		FRMR (frame reject)	1	1	1	0	U	0	0	1	F	0	0	0	0	0	0	0
		UA (unnumbered acknow-ledgement)	1	1	0	0	U	1	1	0	F	0	0	0	0	0	0	0
		DM (disconnected mode)	1	1	1	1	U	0	0	0	F	0	0	0	0	0	0	0

NOTES

1 Bit 5 of unnumbered format frames is unspecified in alternative **b)**.

2 For an interim period, as described in 2.3.2.1.3, Administrations may bilaterally agree to use a format that consists of a 2-octet control field.

2.3.4.3 Receive not ready (RNR) command and response

The Receive not ready (RNR) supervisory frame is used by the STE to indicate a busy condition; i.e., temporary inability to accept additional incoming I frames. I frames numbered up to and including [N(R) – 1] are acknowledged. I frame N(R) and any subsequent I frames received, if any, are not acknowledged; the acceptance status of these I frames will be indicated in subsequent frames.

In addition to indicating the STE status, the RNR command with the P bit set to 1 may be used by an STE to ask for the status of the other STE.

2.3.4.4 Reject (REJ) command and response

The reject (REJ) supervisory frame is used by the STE to request retransmission of I frames starting with the frame numbered N(R). I frames numbered [N(R) – 1] and below are acknowledged. Additional I frames pending initial transmission may be transmitted following the retransmitted I frame(s).

Only one REJ exception condition for a given direction of information transfer may be established at any time. The REJ exception condition is cleared (reset) upon the receipt of an I frame with an N(S) equal to the N(R) of the REJ frame.

An REJ frame may be used to indicate the clearance of a busy condition that was reported by the earlier transmission of an RNR frame by that same STE. In addition to indicating the STE status, the REJ command with the P bit set to 1 may be used by an STE to ask for the status of the other STE.

2.3.4.5 Set asynchronous balanced mode (SABM) command and set asynchronous balanced mode extended (SABME) command

The SABM unnumbered command is used to place the addressed STE in the asynchronous balanced mode (ABM) information transfer phase, where all command/response control fields will be one octet in length.

The SABME unnumbered command is used to place the addressed STE in the asynchronous balanced mode information transfer phase, where numbered command/response control fields will be two octets in length and unnumbered command response fields will be one octet in length (see Note).

No information field is permitted with the SABM and SABME command. The transmission of a SABM/SABME command indicates the clearance of a busy condition that was reported by the earlier transmission of an RNR frame by that same STE. The STE confirms acceptance of SABM/SABME (modulo 8/modulo 128) by the transmission at the first opportunity of an UA response. Upon acceptance of this command both the send state variable and the receive state variable are set to 0.

Previously transmitted I frames that are unacknowledged when this command is actioned remain unacknowledged.

NOTE – For an interim period, as described in 2.3.2.1.3, Administrations may bilaterally agree to use a format that consists of a 2-octet control field.

2.3.4.6 Disconnect (DISC) command

The DISC unnumbered command is used to terminate the mode previously set. It is used to inform the STE receiving the DISC command that the STE sending the DISC command is suspending operation. No information field is permitted with the DISC command. Prior to actioning the DISC command, the addressed STE confirms the acceptance of DISC by the transmission of an UA response. The STE sending the DISC enters the disconnected phase when it receives the acknowledging UA response.

Previously transmitted I frames that are unacknowledged when this command is actioned remain unacknowledged.

2.3.4.7 Unnumbered acknowledge (UA) response

The UA unnumbered response is used by the STE to acknowledge the receipt and acceptance of the mode-setting commands. Received mode-setting commands are not activated until the UA response is transmitted. The transmission of an UA response indicates the clearance of a busy condition that was reported by the earlier transmission of an RNR frame by that same STE. No information field is permitted with the UA response.

2.3.4.8 Disconnected mode (DM) response

The DM unnumbered response is used to report a status where the STE is logically disconnected from the link, and is in the disconnected phase. The DM response is sent in this phase in response to the reception of a set mode command, to inform the STE that the STE is still in disconnected phase and cannot action a set mode command. No information field is permitted with the DM response.

An STE in a disconnected phase will monitor received commands and will react to an SABM/SABME command as outlined in 2.4.4, and will respond with a DM response with the F bit set to 1 to any other command received with the P bit set to 1.

2.3.4.9 Frame reject (FRMR) response

The FRMR unnumbered response is used by the STE to report an error condition not recoverable by retransmission of the identical frame, i.e., at least one of the following conditions, which results from the receipt of a valid frame:

1) the receipt of a command or a response control field that is undefined or not implemented;

2) the receipt of an I frame with an information field which exceeds the maximum established length;

3) the receipt of an invalid N(R);

4) the receipt of a frame with an information field which is not permitted or the receipt of a supervisory or unnumbered frame with incorrect length;

5) the receipt of a supervisory frame with the F bit set to 1, except during a timer recovery condition as described in 2.4.5.9 or except as a reply to a command sent with the P bit set to 1;

6) the receipt of an unexpected UA or DM response;

7) the receipt of an invalid N(S).

An invalid N(R) is defined as one which points to an I frame which has previously been transmitted and acknowledged or to an I frame which has not been transmitted and is not the next sequential I frame awaiting transmission. A valid N(R) must be within the range from the lowest send sequence number N(S) of the still unacknowledged frame(s) to the current STE send state variable included (or to the current internal variable *x* if the STE is in the timer recovery condition as described in 2.4.5.9. This constraint applies even if the STE is in a frame rejection condition.

An invalid N(S) is an in-sequence N(S), i.e. an N(S) equal to V(R), which is equal to the last transmitted N(R) + *k*, where *k* is the maximum number of outstanding frames (see 2.4.8.6). An invalid N(S) denotes a frame window violation.

An information field which immediately follows the control field, and consists of 3 octets (modulo 8) or 5 octets (modulo 128), is returned with this response and provides the reason for the FRMR response. This format is given in Tables 7 and 8.

For condition 4) listed above, bits W and X should be set to 1.

For conditions 5), 6) and 7) listed above, bit W should be set to 1.

In all cases, the STE receiving the FRMR should examine the contents of the rejected frame control field for further clarification of the cause of the error before recording this error.

TABLE 7/X.75

FRMR information field format (modulo 8)

Information field bits												
1 2 3 4 5 6 7 8	9	10 11 12	13	14 15 16	17	18	19	20	21	22	23	24
Rejected frame control field	0	V(S)	C/R	V(R)	W	X	Y	Z	0	0	0	0

Rejected frame control field is the control field of the received frame which caused the frame reject.

V(S) is the current send state variable value at the STE reporting the rejection condition (bit 10 = low-order bit).

C/R set to 1 indicates the rejected frame was a response. C/R set to 0 indicates the rejected frame was a command.

V(R) is the current receive state variable value at the STE reporting the rejection condition (bit 14 = low-order bit).

W set to 1 indicates that the control field received and returned in bits 1 through 8 was invalid or not implemented.

X set to 1 indicates that the control field received and returned in bits 1 through 8 was considered invalid because the frame contained an information field which is not permitted with this frame or is a supervisory or unnumbered frame with incorrect length. Bit W must be set to 1 in conjunction with this bit.

Y set to 1 indicates that the information field received exceeded the maximum established capacity.

Z set to 1 indicates the control field received and returned in bits 1 through 8 contained an invalid N(R).

Bits 9 and 21 through 24 shall be set to 0.

TABLE 8/X.75

FRMR information field format (modulo 128)

Information field bits												
1 to 16	17	18 to 24	25	26 to 32	33	34	35	36	37	38	39	40
Rejected frame control field	0	V(S)	C/R	V(R)	W	X	Y	Z	0	0	0	0

Rejected frame control field is the control field of the received frame which caused the frame reject. When the rejected frame is an unnumbered frame, the control field of the rejected frame is positioned in bit positions 1-8, with 9-16 set to 0. If, however, the interim solution mentioned in 2.3.2.1.3 is adopted, the 2-octet control field will be placed in bit positions 1-16.

V(S) is the current send state variable value at the STE reporting the rejection condition (bit 18 = low order bit).

C/R set to 1 indicates the rejected frame was a response. C/R set to 0 indicates the rejected frame was a command.

V(R) is the current receive state variable value at the STE reporting the rejection condition (bit 26 = low-order bit).

W set to 1 indicates that the control field received and returned in bits 1 through 16 was invalid or not implemented.

X set to 1 indicates that the control field received and returned in bits 1 through 16 was considered invalid because the frame contained an information field which is not permitted with this frame or is a supervisory or unnumbered frame with incorrect length. Bit W must be set to 1 in conjunction with this bit.

Y set to 1 indicates that the information field received exceeded the maximum established capacity.

Z set to 1 indicates the control field received and returned in bits 1 through 16 contained an invalid N(R).

Bits 17 and 37 through 40 shall be set to 0.

2.3.5 Exception condition reporting and recovery

The error recovery procedures which are available to effect recovery following the detection/occurrence of an exception condition at the link layer are described below. Exception conditions described are those situations which may occur as the result of transmission errors, STE malfunction or operational situations.

2.3.5.1 Busy condition

The busy condition results when an STE is temporarily unable to continue to receive I frames due to internal constraints, e.g., receive buffering limitations. In this case an RNR frame is transmitted from the busy STE. I frames pending transmission may be transmitted from the busy STE prior to or following the RNR frame. An indication that the busy condition has cleared is communicated by the transmission of an UA (only in response to a SABM/SABME command), RR, REJ or SABM/SABME (modulo 8/modulo 128) frame.

2.3.5.2 N(S) sequence error condition

The information field of all I frames received whose N(S) does not equal the receive state variable V(R) will be discarded.

An N(S) sequence error exception condition occurs in the receiver when an I frame received contains an N(S) which is not equal to the receive state variable V(R) at the receiver. The receiver does not acknowledge (increment its receive state variable) the I frame causing the sequence error, or any I frame which may follow until an I frame with the correct N(S) is received.

An STE which receives one or more valid I frames having sequence errors or subsequent supervisory frames (RR, RNR and REJ) shall accept the control information contained in the N(R) field and the P/F bit to perform link control functions; e.g., to receive acknowledgement of previously transmitted I frames, and to cause the STE to respond (P bit sent to 1).

2.3.5.2.1 REJ recovery

The REJ frame is used by a receiving STE to initiate a recovery (retransmission) following the detection of an N(S) sequence error.

With respect to each direction of transmission on the link, only one sent REJ exception condition from an STE is established at a time. A sent REJ exception condition is cleared when the requested I frame is received.

An STE receiving REJ initiates sequential (re-)transmission of I frames starting with the I frame indicated by the N(R) obtained in the REJ frame.

The retransmitted frame(s) may contain an N(R) and a P bit that is updated from, and therefore different from, the ones contained in the originally transmitted I frame(s).

2.3.5.2.2 Time-out recovery

If an STE, due to a transmission error, does not receive (or receives and discards) a single I frame or the last I frames in a sequence of I frames, it will not detect an N(S) sequence error condition and therefore will not transmit an REJ frame. The STE which transmitted the unacknowledged I frame(s) shall, following the completion of a system specified time-out period (see 2.4.5.9 and 2.4.8.1), take appropriate recovery action to determine at which I frame retransmission must begin. The retransmitted frames may contain an N(R) and a P bit that are updated from, and therefore different from, the ones contained in the originally transmitted I frames.

2.3.5.3 Invalid frame condition

Any frame which is invalid will be discarded, and no action is taken as the result of that frame. An invalid frame is defined as one which:

a) is not properly bounded by two flags;

b) in non-extended (modulo 8) operation, contains fewer than 32 bits between flags; in extended (modulo 128) operation, contains fewer than 40 bits between flags of frames that contain sequence numbers or 32 bits between flags of frames that do not contain sequence numbers.

NOTE – Or fewer than 40 bits (modulo 128) if 2-octet control field is used as alternative b) during the interim period (see 2.3.2.1.3).

c) contains a Frame check sequence (FCS) error,

d) contains an address other than A or B (for single link operation) or other than C or D (for multilink operation).

For those networks that are octet aligned, a detection of non-octet alignment may be made at the link layer by adding a frame validity check that requires the number of bits between the opening flag and the closing flag, excluding bits inserted for transparency, to be an integral number of octets in length, or the frame considered invalid.

2.3.5.4 Frame rejection condition

A frame rejection condition is established upon the receipt of an error-free frame with one of the conditions listed in 2.3.4.9.

This frame rejection exception condition is reported by sending an FRMR response for appropriate STE action.

Once an STE has established a frame rejection condition, no additional I or S format frames are accepted until the condition is reset except for examination of the P bit. The FRMR response may be repeated at each opportunity, as specified in 2.4.7.3 until recovery is effected by the other STE or until the STE initiates its own recovery in case the other STE does not respond.

2.3.5.5 Excessive idle channel state condition on incoming channel

Upon detection of an idle channel state condition (see 2.2.12.2) on the incoming channel, the STE shall wait for a period T3 (see 2.4.8.3) without taking any specific action, waiting for detection of a return to the active channel state (i.e., detection of at least one flag sequence). After the period T3, the STE shall notify the MLP or the packet layer of the excessive idle channel state condition, but shall not take any action that would preclude the other STE from establishing the link by normal link set-up procedures.

The value of T3 is a system parameter and is agreed bilaterally.

2.4 Description of the procedures

2.4.1 Extended and non-extended modes of operation

Changing from non-extended operation to extended operation, or vice versa, requires bilateral agreement and is not supported dynamically.

Table 5 indicates the command and response control field formats used with the non extended (modulo 8) service. The mode setting command employed to initialize (set up) or reset the non extended mode is the SABM command. Table 6 indicates the command and response control field formats used with the extended (modulo 128) service. The mode setting command employed to initialize (set up) or reset the extended mode is the SABME command.

2.4.2 Procedure for addressing

Commands are sent with the remote STE address and responses are sent with the local STE address.

In order to allow differentiation between single link operation and multilink operation for diagnostic and/or maintenance reasons, different address pair encodings shall be assigned to links operating with the multilink procedure (MLP) compared to links operating with the single link procedure (SLP). These STE addresses are coded as follows:

	Address	1	2	3	4	5	6	7	8
Single link operation	A	1	1	0	0	0	0	0	0
	B	1	0	0	0	0	0	0	0
Multilink operation	C	1	1	1	1	0	0	0	0
	D	1	1	1	0	0	0	0	0

A and B, or C and D, are assigned by bilateral agreement between the Administrations.

2.4.3 Procedure for the use of the P/F bit

The STE receiving an SABM/SABME, DISC, supervisory command or I frame with the P bit set to 1 will set the F bit to 1 in the next response frame it transmits.

The response frame returned by the STE to an SABM/SABME or DISC command with the P bit set to 1 will be an UA or DM response with the F bit set to 1. The response frame returned by the STE to an I frame with the P bit set to 1, received during the information transfer phase, will be an RR, REJ, RNR or FRMR response with the F bit set to 1. The response frame returned by the STE to a supervisory command with the P bit set to 1, received during the information transfer phase, will be an RR, REJ, RNR or FRMR response with the F bit set to 1.

The response frame returned to an I frame or supervisory frame with the P bit set to 1, received in the disconnected phase, will be a DM with F bit set to 1.

The P bit may be used by the STE in conjunction with the time-out recovery condition (see 2.4.5.9).

When not used the P/F bit is set to 0.

NOTE – Other use of the P bit by the STE is a subject for further study.

2.4.4 Procedures for link set up and disconnection

2.4.4.1 Link set up

The STE will indicate that it is able to set up the link by transmitting contiguous flags (active channel state).

Either STE may initialize the link by sending SABM/SABME (modulo 8/modulo 128) and starting Timer T1 in order to determine when too much time has elapsed waiting for a reply. The opposite STE upon receiving SABM/SABME correctly, sends UA and resets both its state variables to 0. If UA is received correctly, then the link is set up and the initiating STE resets both its state variables to 0 and stops Timer T1.

If, upon receipt of SABM/SABME correctly, the STE determines that it cannot enter the indicated phase, it sends the DM response.

When receiving the DM response, the STE which has transmitted an SABM/SABME stops its Timer T1 and does not enter the information transfer phase.

The STE sending SABM/SABME will ignore and discard any frames except SABM/SABME, DISC, UA and DM from the other STE.

Frames other than UA and DM in response to a received SABM/SABME will be sent only after the link is set up and if no outstanding SABM/SABME exists.

If an SABM/SABME or DISC command, UA or DM response is not received correctly, the result will be that the Timer T1 will run out in the STE which originally sent the SABM/SABME and that the STE may resend SABM/SABME and restart Timer T1.

After transmission of SABM/SABME N2 times by the STE, appropriate recovery action will be initiated.

The value of N2 is defined in 2.4.8.4.

2.4.4.2 Information transfer phase

After having transmitted the UA response to the SABM/SABME command or having received the UA response to a transmitted SABM/SABME command, the STE will accept and transmit I and supervisory frames according to the procedures described in 2.4.5.

When receiving an SABM/SABME (modulo 8/modulo 128) command while in the information transfer phase, the STE will conform to the resetting procedure described in 2.4.7.

2.4.4.3 Link disconnection

During the information transfer phase, either STE shall indicate a request for disconnecting the link by transmitting a DISC command, and it shall start Timer T1 (see 2.4.8.1).

The STE, on correctly receiving a DISC command, will send a UA response and enter the disconnected phase. The STE, on receiving a UA or DM response to a sent DISC command, stops its timer, and enters the disconnected phase. If a UA or DM response is not received correctly, this will result in the expiration of the Timer T1 in the STE which originally sent the DISC command. If Timer T1 runs out, this STE will retransmit a DISC command and restart Timer T1. This action will continue until a UA response or a DM response is correctly received or until recovery takes place at a higher layer after transmission of DISC N2 times. The value of N2 is defined in 2.4.8.4.

2.4.4.4 Disconnected phase

2.4.4.4.1 After having received a DISC command and returned a UA response, or having received the UA response to a transmitted DISC command, the STE will enter the disconnected phase.

In the disconnected phase, the STE may initiate link set up. In the disconnected phase, the STE will react to the receipt of an SABM/SABME command as described in 2.4.4.1, will react to the receipt of an unsolicited DM response in accordance with 2.3.4.8 and will transmit a DM response in answer to a received DISC command.

When receiving any other command frame (defined, or undefined or not implemented) with the P bit set to 1, the STE will transmit a DM response with the F bit set to 1. Other frames received in the disconnected phase will be ignored.

2.4.4.4.2 After recovery from an internal malfunction, the STE may either initiate a resetting procedure (see 2.4.7) or disconnect the link (see 2.4.4.3) prior to a link set up procedure (see 2.4.4.1).

2.4.4.5 Collision of unnumbered commands

Collision situations shall be resolved in the following way.

2.4.4.5.1 If the sent and received unnumbered commands are the same, each STE shall send the UA response at the earliest possible opportunity. Each STE shall enter the indicated phase after receiving a UA response.

2.4.4.5.2 If the sent and received unnumbered commands are different, each STE shall enter the disconnected phase and issue a DM response at the earliest possible opportunity.

2.4.5 Procedures for information transfer

The procedures which apply to the transmission of I frames in each direction during the information transfer phase are described below.

In the following, “number one higher” is in reference to a continuously repeated sequence series, i.e., 7 is 1 higher than 6 and 0 is 1 higher than 7 for modulo 8 series, and 127 is 1 higher than 126 and 0 is 1 higher than 127 for modulo 128 series.

2.4.5.1 Sending I frames

When the STE has an I frame to transmit (i.e., an I frame not already transmitted, or having to be retransmitted as described in 2.4.5.6), it will transmit it with an N(S) equal to its current send state variable V(S), and an N(R) equal to its current receive state variable V(R). At the end of the transmission of the I frame, it will increment its send state variable V(S) by 1.

If the Timer T1 is not running at the time of transmission of an I frame, it will be started.

If the send state variable V(S) is equal to the last value of N(R) received plus k (where k is the maximum number of outstanding I frames, see 2.4.8.6) the STE will not transmit any new I frames, but may retransmit an I frame as described in 2.4.5.6 or 2.4.5.9.

When the STE is in a busy condition, it may still transmit I frames provided that the other STE is not busy. When in the frame rejection condition, the STE will stop transmitting I frames.

2.4.5.2 Receiving an 1 frame

2.4.5.2.1 When the STE is not in a busy condition and receives a valid I frame whose send sequence number N(S) is equal to the STE receive state variable V(R), the STE will accept the information field of this frame, increment by one its receive state variable V(R), and act as follows:

a) If the STE is still not in a busy condition:

   i) If an I frame is available for transmission by the STE, it may act as in 2.4.5.1 and acknowledge the received I frame by setting N(R) in the control field of the next transmitted I frame to the value of the STE receive state variable V(R). The STE may also acknowledge the received I frame by transmitting an RR with the N(R) equal to the value of the STE receive state variable V(R).

   ii) If no I frame is available for transmission by the STE, it will transmit an RR with the N(R) equal to the value of the STE receive state variable V(R).

b) If the STE is now in a busy condition, it will transmit an RNR frame with N(R) equal to the value of the STE receive state variable V(R) (see 2.4.5.8).

2.4.5.2.2 When the STE is in a busy condition, it may ignore the information field contained in a received I frame.

2.4.5.3 Reception of invalid frames

When the STE receives an invalid frame (see 2.3.5.3), this frame will be discarded.

2.4.5.4 Reception of out of sequence I frames

When the STE receives a valid I frame whose send sequence number is incorrect, i.e., not equal to the current STE receive state variable V(R), it will discard the information field of the frame and transmit a REJ frame with the N(R) set to one higher than the N(S) of the last correctly received I frame. The REJ frame will be a command frame with the P bit set to 1 if an acknowledged transfer of the retransmission request is required; otherwise the REJ frame may be either a command or a response frame. The STE will then discard the information field of all I frames received until the expected 1 frame is correctly received. When receiving the expected I frame, the STE will then acknowledge the I frame as described in 2.4.5.2. The STE will use the N(R) and P bit information in the discard I frames, as described in 2.3.5.2.

2.4.5.5 Receiving acknowledgement

When correctly receiving an I frame or a supervisory frame (RR, RNR or REJ), even in the busy condition except in the frame rejection condition, the STE will consider the N(R) contained in this frame as an acknowledgement for all I frames it has transmitted with an N(S) up to and including the received N(R) – 1. The STE will stop Timer T1 when it correctly receives an I frame or a supervisory frame with the N(R) higher than the last received N(R) (actually acknowledging some I frames), or an REJ frame with an N(R) equal to the last received N(R).

If Timer T1 has been reset and if there are outstanding I frames still unacknowledged, Timer T1 will be restarted. If Timer T1 then runs out, the STE will follow the retransmission procedure (in 2.4.5.9) with respect to the unacknowledged I frames.

2.4.5.6 Receiving an REJ frame

When receiving an REJ frame, the STE will set its send state variable V(S) to the N(R) received in the REJ control field. It will transmit the corresponding I frame as soon as it is available or retransmit it in accordance with the procedures described in 2.4.5.1. (Re)transmission will conform to the following procedure:

i) If the STE is transmitting a supervisory command or response when it receives the REJ frame, it will complete that transmission before commencing transmission of the requested I frame.

ii) If the STE is transmitting an unnumbered command or response when it receives the REJ frame, it will ignore the request for retransmission.

iii) If the STE is transmitting an I frame when the REJ frame is received, it may abort the I frame and commence transmission of the requested I frame immediately after abortion.

iv) If the STE is not transmitting any frame when the REJ frame is received, it will commence transmission of the requested I frame immediately.

In all cases, if other unacknowledged I frames have already been transmitted following the one indicated in the REJ frame, then those I frames will be retransmitted by the STE following the retransmission of the requested I frame. Other I frames not yet transmitted may be transmitted following the retransmitted I frames.

If the REJ frame was received from the other STE as a command with the P bit set to 1, the STE will transmit an RR, RNR or REJ response with the F bit set to 1 before transmitting or retransmitting the corresponding I frame.

2.4.5.7 Receiving an RNR frame

After receiving an RNR frame whose N(R) acknowledges all frames previously transmitted, the STE will stop Timer T1 and may then transmit an I frame, with the P bit set to 0, whose send sequence number is equal to the N(R) indicated in the RNR frame, restarting the Timer T1 as it does. After receiving an RNR frame whose N(R) indicates a previously transmitted frame, the STE will not transmit or retransmit any I frame, Timer T1 being already running. In either case, if the Timer T1 runs out before receipt of a busy clearance indication, the STE will follow the procedure described in 2.4.5.9. In any case, the STE will not transmit any other I frames before receiving an RR or REJ frame or before the completion of a link resetting procedure.

2.4.5.8 STE busy condition

When the STE enters a busy condition, it will transmit an RNR frame at the earliest opportunity. The RNR frame will be a command frame with the P bit set to 1 if an acknowledged transfer of the busy condition indication is required; otherwise the RNR frame may be either a command or response frame. While in the busy condition, the STE will accept and process supervisory frames, will accept and process the contents of the N(R) fields of I frames, and will return an RNR response with the F bit set to 1 if it receives a supervisory command or I command frame with the P bit set to 1. To clear the busy condition, the STE will transmit either an REJ frame or an RR frame, with N(R) set to the current receive state variable V(R), depending on whether or not it discarded information fields of correctly received I frames. The REJ frame or the RR frame will be a command frame with the P bit set to 1 if an acknowledged transfer of the busy-to-non-busy transition is required, otherwise the REJ frame or the RR frame may be either a command or a response frame.

2.4.5.9 Waiting acknowledgement

If Timer T1 runs out waiting for the acknowledgement from the other STE for an I frame transmitted, the STE will enter the timer recovery condition, add one to its transmission attempt variable and set an internal variable “x” to the current value of its send state variable V(S). The STE will then restart Timer T1, set its send state variable to the last value of N(R) received from the other STE and retransmit the corresponding I frame with the P bit set to 1, or transmit an appropriate supervisory command frame (RR, RNR or REJ) with the P bit set to 1.

The timer recovery condition is cleared when the STE receives a valid supervisory frame with the F bit set to 1.

If, while in the timer recovery condition, the STE correctly receives a supervisory frame with the F bit set to 1 and with the N(R) within the range from its current send state variable V(S) to x included, it will clear the timer recovery condition (including stopping Timer T1) and set its send state variable V(S) to the value of the received N(R), and may then resume with I frame transmission or retransmission, as appropriate.

If, while in the timer recovery condition, the STE correctly receives an I frame or a supervisory frame with the P/F bit set to 0 and with a valid N(R) (see 2.3.4.9) within the range from its current send state variable V(S) to x included, it will not clear the timer recovery condition. The value of the received N(R) may be used to update the send state variable V(S). However, the STE may decide to keep the last transmitted I frame in store (even if it is acknowledged) in order to be able to retransmit it when the P bit set to 1 when Timer T1 runs out at a later time.

If Timer T1 runs out in the timer recovery condition, the STE will add one to its transmission attempt variable, restart Timer T1, and either retransmit the I frame sent with the P bit set to 1 or transmit an appropriate supervisory command with the P bit set to 1.

If the transmission attempt variable is equal to N2, the STE will initiate a link resetting procedure as described in 2.4.7.2. N2 is a system parameter (see 2.4.8.4).

2.4.6 Conditions for link resetting or link reinitialization (link set-up)

2.4.6.1 When the STE receives, during the information transfer phase, a frame which is not invalid (see 2.3.5.3) with one of the conditions listed in 2.3.4.9, the STE will request the other STE to initiate a link resetting procedure by transmitting an FRMR response as described in 2.4.7.3.

2.4.6.2 When the STE receives, during the information transfer phase, an FRMR response from the other STE, the STE will initiate the link resetting procedures as described in 2.4.7.2.

2.4.7 Procedure for link resetting

2.4.7.1 The link resetting procedure is used to initialize both directions of information transfer according to the procedure described below. The link resetting procedure only applies during the information transfer phase.

2.4.7.2 The link resetting procedure indicates a clearance of the busy condition, if present.

The STE will initiate a link resetting by transmitting an SABM/SABME command to the other STE and starting its Timer T1 (see 2.4.8.1). Upon reception of a UA response from the other STE, the STE will reset its send and receive state variables V(S) and V(R) to zero, will stop its Timer T1, and will remain in the information transfer phase. Upon reception of a DM response from the DTE as a denial to the link resetting request, the STE will stop its Timer T1 and will enter the disconnected phase.

If upon receipt of the SABM/SABME command correctly, the STE determines that it can continue in the information transfer phase, it will return a UA response, will reset its send and receive state variables V(S) and V(R) to zero, and will remain in the information transfer phase. If, upon receipt of the SABM/SABME command correctly, the STE determines that it cannot remain in the information transfer phase, it will return a DM response as a denial to the resetting request and will enter the disconnected phase.

The STE, having sent an SABM/SABME command, will ignore and discard any frames except an SABM/SABME or DISC command, UA or DM response received. The receipt of an SABM/SABME or DISC command from the other STE will result in a collision situation that is resolved per 2.4.4.5. Frames other than the UA or DM response sent in response to a received SABM/SABME or DISC command will be sent only after the link is reset and if no outstanding SABM/SABME command exists.

After the STE sends the SABM/SABME command, if a UA or DM response is not received correctly, Timer T1 will run out. The STE will then resend the SABM/SABME command and will restart Timer T1. After N2 attempts to reset the link, the STE will initiate appropriate higher layer recovery action and will enter the disconnected phase. The value of N2 is defined in 2.4.8.4.

2.4.7.3 The STE may ask the other STE to reset the link by transmitting an FRMR response (see 2.4.6.1).

After transmitting an FRMR response, the STE will enter the frame rejection condition. The frame rejection condition is cleared when the STE receives or transmits an SABM/SABME or DISC command. Any other frame received while in the frame rejection condition will cause the STE to retransmit the FRMR response with the same information field as originally transmitted.

The STE may start Timer T1 on transmission of the FRMR response. If Timer T1 runs out before the frame rejection condition is cleared the STE may retransmit the FRMR response, and restart Timer T1. After N2 attempts to get the other STE to reset the link, the STE may reset the link itself as described in 2.4.7.2. The value of N2 is defined in 2.4.8.4.

In the frame rejection condition, I frames and supervisory frames will not be transmitted. Also, received I frames and supervisory frames will be discarded by the STE except for the observance of a P bit set to 1. When an additional FRMR response must be transmitted as a result of the receipt of a P bit set to 1 while Timer T1 is running, Timer T1 will continue to run.

Upon reception of a FRMR response (even during a frame rejection condition), the STE will initiate a resetting procedure by transmitting a SABM/SABME command as described in 2.4.7.2.

2.4.8 List of system parameters

The system parameters are as follows:

2.4.8.1 Timer T1

The period of Timer T1, at the end of which transmission of a frame may be initiated, is a system parameter agreed for a period of time between the Administrations.

The period of Timer T1 will take into account whether the timer is started at the beginning or end of transmission of the frame in the STE.

The proper operation of the procedure requires that the transmitter's Timer T1 be greater than the maximum time between transmission of a frame (SABM/SABME, DISC, I for supervisory command, or DM or FRMR response) and the reception of the corresponding frame) returned as an answer to that frame (UA, DM or acknowledging frame). Therefore, the receiver STE should not delay the response or acknowledging frame returned to one of the above frames by more than a value T2, where T2 is a system parameter (see 2.4.8.2).

The STE will not delay the response or acknowledging frame returned to one of the above frames by more than a period T2.

2.4.8.2 Parameter T2

The period of parameter T2 shall indicate the amount of time available at the STE before the acknowledging frame must be initiated in order to ensure its receipt by the other STE prior to Timer T1 running out at the STE (parameter T2 < Timer T1).

2.4.8.3 Timer T3

The STE shall support a Timer T3 system parameter, the value of which shall be made known to both STEs.

The period of Timer T3, at the end of which an indication of an observed excessively long idle channel state condition is passed to the packet layer or the MLP, shall be sufficiently greater than the period of the Timer T1 (i.e., T3 > T1) so that the expiration of T3 provides the desired level of assurance that the link channel is in a non-active, non-operational state, and is in need of link set up before nominal link operation can resume.

2.4.8.4 Maximum number of attempts to complete a transmission, N2

The value of the maximum number N2 of transmission and retransmissions of a frame following the running out of Timer T1 is a system parameter agreed for a period of time between Administrations. The value of N2 can be different in STE-X and STE-Y.

2.4.8.5 Maximum number of bits in an I frame, N1

The maximum number of bits in an I frame (excluding flags and 0 bits inserted for transparency) is a system parameter which depends upon the maximum length of the information fields transferred across the X/Y interface.

NOTE – When multilink procedures are used, N1 shall allow for the multilink control field (MLC). See 2.5.2. Appendix II/X.25 provides additional information on N1. The utility field has to be added.

2.4.8.6 Maximum number of outstanding I frames, k

The maximum number (*k*) of sequentially numbered I frames that the STE may have outstanding (i.e., unacknowledged) at any given time is a system parameter which can never exceed 7/127 (modulo 8/modulo 128). It shall be agreed for a period of time between Administrations and shall have the same value for both the STEs.

2.5 Multilink procedures (MLP)

The multilink procedure (MLP) exists as an added upper sublayer of the data link layer, operating between the packet layer and a multiplicity of single data link protocol functions (SLPs) in the data link layer (see Figure 2).

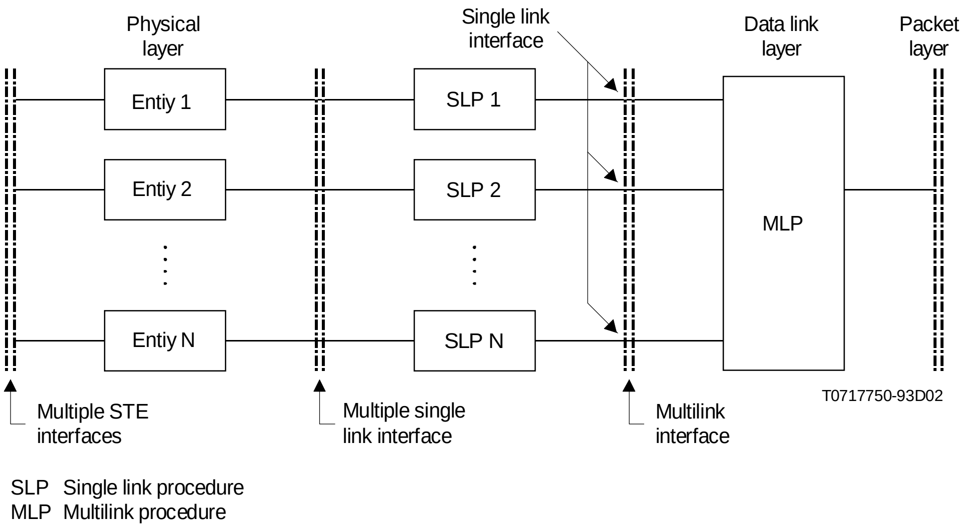


FIGURE 2/X.75

Multilink functional organization

A multilink procedure (MLP) must perform the functions of distributing across the available SLPs, packets which are to be transmitted to the remote STE and of resequencing packets received from the remote STE for delivery to the packet layer.

NOTES

1 In 2.5.4.4 (MT1 expiry) and 2.5.4.5 (retransmission), other mechanisms can be envisaged to achieve the same functions.

2 In 2.5.5.4 (MN1), 2.5.5.1 (MT1) and 2.5.5.2 (MT2) other mechanisms can be envisaged to achieve the same functions.

2.5.1 Field of application

The optional multilink procedure (MLP) described below is used for data interchange over one or more single link procedures (SLPs), each conforming to the description in 2.2, 2.3 and 2.4, in parallel between two STEs. The multilink procedure provides the following general features:

a) achieve economy and reliability of service by providing multiple SLPs between two STEs;

b) permit addition and deletion of SLPs without interrupting the service provided by the multiple SLPs;

c) optimize bandwidth utilization of a group of SLPs through load sharing;

d) achieve graceful degradation of service when an SLP(s) fails;

e) provide each multiple SLP group with a single logical data link layer appearance to the packet layer; and

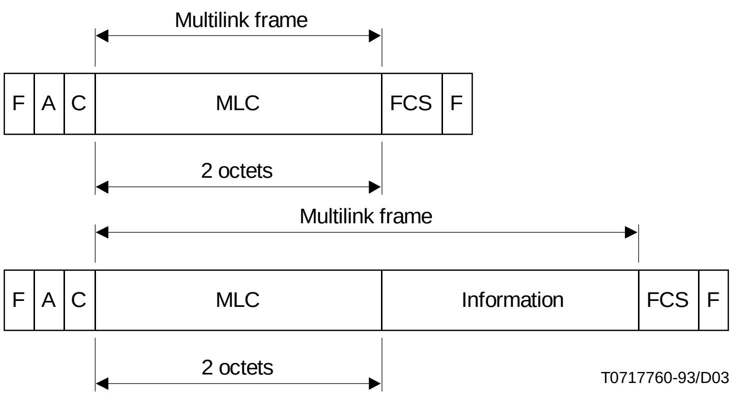
f) provide sequencing of the received packets prior to delivering them to the packet layer.

2.5.2 Multilink frame structure

All information transfers over an SLP are in multilink frames conforming to one of the formats shown in Table 9.

TABLE 9/X.75

Multilink frame formats



2.5.2.1 Multilink control field

The multilink control field (MLC) consists of two octets and its contents are described in 2.5.3.

2.5.2.2 Multilink information field

The information field of a multilink frame, when present, follows the MLC. See 2.5.3.2.3, 2.5.3.2.4 and 4 for the various codings and grouping of bits in the multilink information field.

2.5.3 Multilink control field format and parameters

2.5.3.1 Multilink control field format

The relationship shown in Table 10 exists between the order of bits delivered to/received from an SLP and the coding of the fields in the multilink control field.

2.5.3.2 Multilink control field parameters

The various parameters associated with the multilink control field format are described below. See Table 10 and Figure 3.

2.5.3.2.1 Void sequencing bit (V)

The void sequencing bit (V) indicates if a received multilink frame shall be subjected to sequencing constraints. V set to 1 means sequencing shall not be required. V set to 0 means sequencing shall be required.

NOTE – For the purpose of this Recommendation, this bit shall be set to 0.

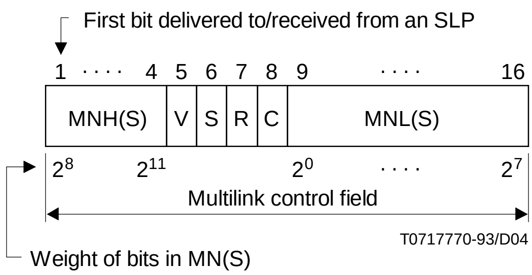
2.5.3.2.2 Sequence check option bit (S)

The sequence check option bit (S) is only significant when V is set to 1 (indicating that sequencing of received multilink frames shall not be required). S set to 1 shall mean no MN(S) number has been assigned. S set to 0 shall mean an MN(S) number has been assigned, so that although sequencing shall not be required, a duplicate multilink frame check may be made, as well as a missing multilink frame identified.

NOTE – For the purpose of this Recommendation, this bit shall be set to 0.

TABLE 10/X.75

Multilink control field format



MNH(S)	Bits 9-12 of 12-bit multilink send sequence number MN(S)
MNL(S)	Bits 1-8 of 12-bit multilink send sequence number MN(S)
V	Void sequencing bit
S	Sequence check option bit
R	MLP reset request bit
C	MLP reset confirmation bit

2.5.3.2.3 MLP reset request bit (R)

The MLP reset request bit (R) is used to request a multilink reset (see 2.5.4.2). R set to 0 is used in normal communication; i.e., no request for a multilink reset. R set to 1 is used by the STE MLP to request the reset of the remote MLP state variables. In this R = 1 case, the multilink information field does not contain packet layer information, but may contain an optional 8-bit cause field that incorporates the reason for the reset.

NOTE – The encoding of the cause field is a subject for further study.

2.5.3.2.4 MLP reset confirmation bit (C)

The MLP reset confirmation bit (C) is used in reply to an R bit set to 1 (see 2.5.3.2.3) to confirm the resetting of the multilink state variables (see 2.5.4.2). C set to 0 is used in normal communication; i.e., no multilink reset request has been activated. C set to 1 is used by the STE MLP in reply to a multilink frame from the remote STE with R set to 1, and indicates that the MLP state variable reset process has been completed. In this C = 1 case, the multilink frame is used without an information field.

2.5.3.2.5 Multilink send state variable MV(S)

The multilink send state variable MV(S) denotes the sequence number of the next in-sequence multilink frame to be assigned to an SLP. The variable can take on the value 0 through 4095 (modulus 4096). The value of MV(S) is incremented by 1 with each successive multilink frame assignment.

2.5.3.2.6 Multilink sequence number MN(S)

Multilink frames contain the multilink sequence number MN(S). Prior to the assignment of an in-sequence multilink frame, the value of MN(S) is updated to equal the value of the multilink send state variable MV(S). The multilink sequence number is used to resequence and to detect missing and duplicate multilink frames at the receiver before the contents of a multilink frame information field is delivered to the packet layer.

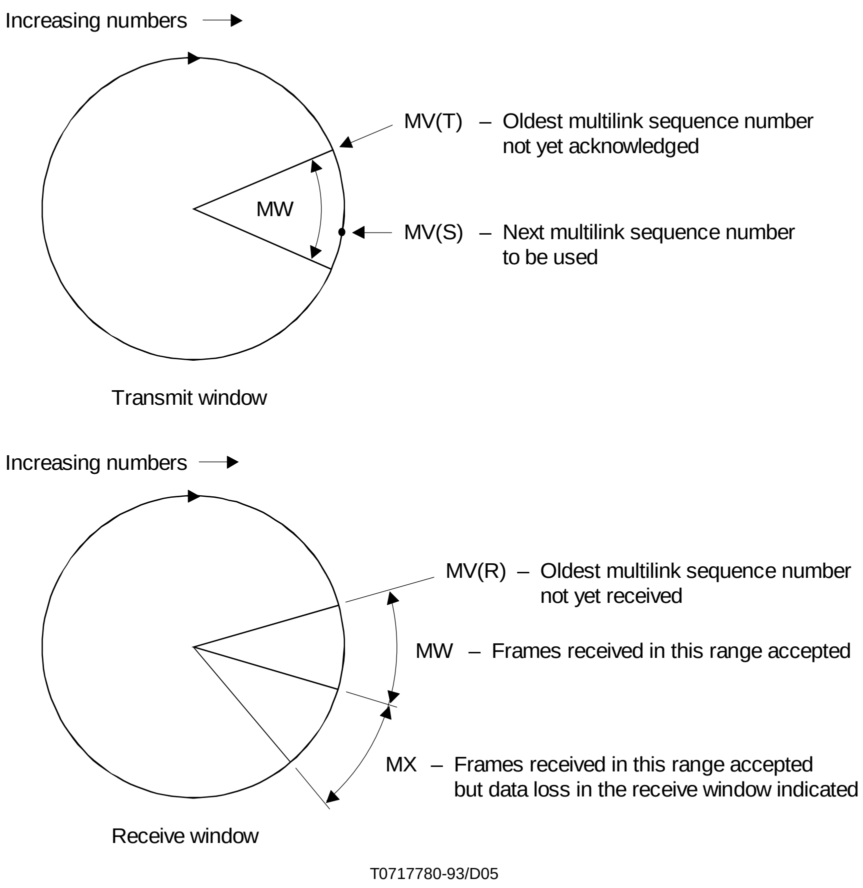


FIGURE 3/X.75

Parameters

2.5.3.2.7 Transmitted multilink acknowledged state variable MV(T)

MV(T) is the state variable at the transmitting STE denoting the oldest multilink frame which is awaiting an indication that a local SLP has received an acknowledgement from its remote SLP. This variable MV(T) can take on the value 0 through 4095 (modulus 4096). Some multilink frames with sequence numbers higher than MV(T) may already have been acknowledged.

2.5.3.2.8 Multilink receive state variable MV(R)

The multilink receive state variable MV(R) denotes the sequence number at the receiving STE of the next in-sequence multilink frame to be received and delivered to the packet layer. This variable MV(R) can take on the value 0 through 4095 (modulus 4096). The value of MV(R) is updated as described in 2.5.4.4. Multilink frames with higher sequence numbers in the MLP receive window may already have been received.

2.5.3.2.9 Multilink window size MW

MW is the maximum number of sequentially numbered multilink frames that the STE may transfer to its SLPs beyond the lowest numbered multilink frame which has not as yet been acknowledged. MW is a system parameter which can never exceed (4095 – MX).

The value of MW shall be agreed between Administrations and shall have the same value for both STEs for a given direction of information transfer.

NOTE – Factors which will affect the value of parameter MW include, but are not limited to single link transmission and propagation delays, the number of links, the range of multilink frame lengths, and SLP parameters N2, T1 and *k*.

The MLP transmit window contains the sequence numbers MV(T) to [MV(T) + MW – 1] inclusive.

The MLP receive window contains the sequence numbers MV(R) to [MV(R) + MW–1] inclusive. Any multilink frame received within this window shall be delivered to the packet layer when its MN(S) is the same as MV(R).

2.5.3.2.10 Receive MLP window guard region MX

MX is a system parameter which defines a guard region of multilink sequence numbers of fixed size beginning at [MV(R) + MW]. The range of MX shall be large enough for the receiving MLP to recognize the highest MN(S) outside of its receive window that it may legitimately receive after a multilink frame loss has occurred.

A multilink frame with sequence number MN(S) = Y received in this guard region indicates that those missing multilink frame(s) in the range MV(R) to [Y – MW] has (have) been lost. MV(R) is then updated to [Y – MW + 1].

NOTE – A number of methods may be selected in calculating a value for the guard region MX:

a) In a system where the transmission MLP assigns h_i in-sequence contiguous multilink frames at a time to the *i*th SLP, MX should be greater than or equal to the sum of [$h_i + 1 - h_{min}$], where h_{min} equals the smallest h_i encountered. Where there are *L* SLPs in the multilink group, MX should be greater than or equal to:

$$\sum_{i=1}^{L} h_i + 1 - h_{min}; \text{ or}$$

b) In a system where the transmitting MLP assigns on a rotation basis *h* in-sequence, contiguous multilink frames at a time to each SLP, MX at the receiving MLP should be greater than or equal to [$h(L - 1) + 1$], where *L* is the number of SLPs in the multilink group; or

c) MX should be no larger than MW.

Additional methods of selecting MX values are for further study.

2.5.4 Description of multilink procedure (MLP)

The procedure below is presented from the perspective of the transmitter and receiver of multilink frames.

The arithmetic is performed modulo 4096.

2.5.4.1 Initialization

The STE will perform an MLP initialization by first resetting MV(S), MV(T), and MV(R) to zero and then initializing each of its SLPs. Upon successful initialization of at least one of the SLPs, the STE shall perform the multilink resetting procedure as described in 2.5.4.2. An SLP initialization is performed according to 2.4.4.1.

NOTE – An SLP that cannot be initialized should be declared out of service and appropriate recovery action should be taken.

2.5.4.2 Multilink resetting procedure

The multilink resetting procedure provides the mechanism for synchronizing the sending and receiving MLPs in both STEs when deemed necessary by either STE. Exact cases when a MLP reset procedure will be invoked are for further study. Following a successful multilink resetting procedure, the multilink sequence numbering in each direction begins with the value 0.

Appendix I provides examples for the multilink resetting procedures when initiated by either a single STE or by both STEs simultaneously.

A multilink frame with R = 1 is used to request multilink reset, and a multilink frame with C = 1 confirms that the multilink reset process has been completed. An MLP resets MV(S) and MV(T) to zero on transfer of a multilink frame with R = 1 and resets the MV(R) to zero on receipt of a multilink frame with R = 1.

When the MLP initiates the resetting procedure, it removes all of the unacknowledged multilink frames that are held in that MLP and its associated SLPs, and retains control of those frames. Hereafter, the initiating MLP does not transmit a multilink frame with R = C = 0 until the reset process is completed. (One method to remove multilink frames in the SLP is to disconnect the link of that SLP.) The initiating MLP then resets its multilink send state variable MV(S) and its transmitted multilink frame acknowledged state variable MV(T) to zero. The initiating MLP then transmits a multilink frame with R = 1 as a reset request on one of its SLPs and starts Timer MT3. The value of the MN(S) field in the R = 1 frame may be any value, since when R = 1 the MN(S) field is ignored by the receiving MLP. The initiating MLP continues to receive and process multilink frames from the remote MLP, in accordance with the procedures as described in 2.5.4.4 until it receives a multilink frame with R = 1 from the remote MLP.

An MLP which has received a multilink frame with R = 1 (reset request) in the normal communication status from an initiating MLP starts the operation as described above; the MLP should receive no multilink frames with R = C = 0 until the reset process is completed. Any such frame received is discarded. When the MLP has already initiated its own multilink resetting procedure and has transferred the multilink frame with R = 1 to one of its SLPs for transmission, that MLP does not repeat the above operation upon receipt of a multilink frame with R = 1 from the remote MLP.

Receipt of a frame with R = 1 (reset request) causes the receiving MLP to deliver to the packet layer those packets already received and to identify those multilink frames transmitted but unacknowledged. The packet layer may be informed of the packet loss at the original value of MV(R) and at any subsequent value(s) of MV(R) for which there has been no multilink frame received up to and including the highest numbered multilink frame received. The receiving MLP then resets its multilink receive state variable MV(R) to zero.

After an MLP transmits a multilink frame with R = 1 on one of its SLPs, it shall receive confirmation of successful transfer from that SLP as one of the conditions before transmitting a multilink frame with C = 1; when the initiating MLP then received a multilink frame with R = 1, and has completed the variable resetting operation above, the initiating MLP transmits a multilink frame with C = 1 (reset confirmation) to the remote MLP. When an MLP has

1) received a multilink frame with R = 1,

2) sent a multilink frame with R = 1 on one of its SLPs, and

3) completed the variable resetting operation above,

that MLP then transmits a multilink frame with C = 1 (reset confirmation) to the initiating MLP as soon as possible, given that confirmation of the transfer of the R = 1 multilink frame has been received from that SLP. The C = 1 multilink frame is a reply to the multilink frame with R = 1. The value of the MN(S) field in the above C = 1 frame may be any value, since with C = 1 the MN(S) field is ignored by the receiving MLP. The multilink sequence number MN(S) received in each direction following multilink reset will begin with the value zero.

When an MLP uses the same or only one SLP to transmit the multilink frame with C = 1, the MLP can transmit the multilink frame with C = 1 immediately after the multilink frame with R = 1 without waiting for SLP indication of transfer completion. An MLP may use two different SLPs as long as one is used for transmitting the multilink frame with R = 1 and the other is used for transmitting the multilink frame with C = 1 following receipt of the SLP indication of successful transmission of the R = 1 multilink frame. A multilink frame with R = C = 1 is never used and will be discarded if received.

When an MLP receives the multilink frame with C = 1, the MLP stops its Timer MT3. The successful transmission of the multilink frame with C = 1 to the remote MLP and the reception of a multilink frame with C = 1 from the remote MLP completes the resetting procedure. The first multilink frame transmitted with R = C = 0 shall have a multilink sequence number MN(S) value of zero. (The originating MLP, having successfully delivered a multilink frame with C = 1 to the remote MLP, and having received a multilink frame with C = 1, could immediately transmit multilink frames with R = C = 0. However, to insure that the multilink frames with R = C = 0 are not discarded because they arrive at the remote MLP prior to the SLP acknowledgement of the reception of the C = 1 multilink frame, the MLP should use the same SLP as that which acknowledged receipt of the multilink frame with C = 1.)

When the initiating MLP receives a multilink frame with C = 1 without having received a multilink frame with R = 1, it will retransmit the multilink frame with R = 1 and restart its Timer MT3.

When an MLP additionally receives one or more multilink frames with R = 1 between receiving a multilink frame with R = 1 and transmitting a multilink frame with C = 1, the MLP shall discard the extra multilink frames with R = 1. When an MLP receives a multilink frame with C = 1, which is not a reply to a multilink frame with R = 1, the MLP shall discard the multilink frame with C = 1.

After an MLP transmits a multilink frame with C = 1 on one of its SLPs, the MLP may receive a multilink frame with R = 1 from the remote MLP. The MLP shall regard the multilink frame with R = 1 as a new reset request and shall Start the multilink resetting procedure from the beginning.

When Timer MT3 runs out, the MLP restarts the multilink resetting procedure from the beginning. The value of Timer MT3 shall be large enough to include the transmission, retransmission and propagation delays in the SLPs, and the operation time of the MLP that receives a multilink frame with R = 1 and responds with a multilink frame with C = 1.

2.5.4.3 Transmitting multilink frames

2.5.4.3.1 General

The transmitting STE MLP shall be responsible for controlling the flow of packets from the packet level into multilink frames and then to the SLPs for transmission to the receiving STE MLP.

The functions of the transmitting STE MLP shall be to:

1) accept packets from the packer layer,

2) allocate multilink control fields, containing the appropriate sequence number MN(S), to the packets;

3) assure that MN(S) is not assigned outside the MLP transmit window (MW);

4) pass the resultant multilink frames to the SLPs for transmission;

5) accept indications of successful transmission acknowledgements from the SLPs;

6) monitor and recover from transmission failures or difficulties that occur at the SLP sublayer; and

7) accept flow control indications from the SLPs and take appropriate actions.

2.5.4.3.2 Transmission of multi link frames

When the transmitting MLP accepts a packet from the packet layer, it shall place the packet in a multilink frame, set the MN(S) equal to MV(S), assure that MN(S) is not assigned outside the transmit window (MW), set V, S, R and C to 0, and then increment MV(S) by 1.

In the following, incrementing send and receive state variables is in reference to a continuously repeated sequence series, i.e., 4095 is 1 higher than 4094, and 0 is 1 higher than 4095 for modulo 4096 series.

If the MN(S) is less than MV(T) + MW, and the remote STE has not indicated a busy condition on all available links, the transmitting MLP may then assign the new multilink frame to an available link. The transmitting MLP shall always assign the lowest MN(S) unassigned multilink frame first. Also, the transmitting MLP may assign a multilink frame to more than one link. When the SLP successfully completes the transmission of a multilink frame(s) by receiving an acknowledgement from the remote SLP, it shall indicate this to the transmitting MLP. The transmitting MLP may then discard the acknowledged multilink frame(s). As the transmitting STE receives new indications of acknowledgements from the SLPs, MV(T) shall be advanced to denote the lowest numbered multilink frame not yet acknowledged.

Whenever an SLP indicates that it has attempted to transmit a multilink frame N2 times, the MLP will then assign the multilink frame to the same or one or more other links, unless the MN(S) has been acknowledged on some previous link. The MLP shall always assign the lowest MN(S) frame first.

NOTE 1 – If an MLP implementation is such that a multilink frame is transmitted on more than one link (e.g., to increase the probability of successful delivery) there is a possibility that one of these multilink frames (i.e., a duplicate) may be delivered to the remote MLP after an earlier one has been acknowledged [the earlier multilink frame would have resulted in the receiving remote MLP having incremented its MV(R) and the transmitting MLP having incremented its MV(T)]. To ensure that an old duplicate multilink frame is not mistaken for a new frame by the receiving remote MLP, it is required that the transmitting MLP shall never send a new multilink frame with MN(S) equal to MN(S)′ – MW – MX, where MN(S)′ is associated with a duplicate multilink frame that is being transmitted on other SLPs, until all SLPs have either successfully transferred the multilink frame or retransmitted the frame their maximum number of times. Alternatively, the incrementing of MV(T) may be withheld until all SLPs have either successfully transferred the multilink frame or retransmitted the frame their maximum number of times. These and other alternatives are for further study.

Flow control is achieved by the window size parameter MW, and through busy conditions being indicated by the remote SLPs.

The MLP will not assign a multilink frame with an MN(S) greater than MV(T) + MW – 1. At the point where the next multilink frame to be assigned has a MN(S) = MV(T) + MW, the MLP shall hold this and subsequent multilink frames until an indication of acknowledgement that advances MV(T) is received from the SLPs.

The remote MLP may exercise flow control of the MLP by indicating a busy condition over one or more remote STE SLPs. The number of SLPs made busy will determine the degree of MLP flow control realized. When the MLP receives an indication of a remote SLP busy condition from one or more of its SLPs, the MLP may reassign any unacknowledged multilink frames that were assigned to those SLPs. The MLP will assign the multilink frames containing the lowest MN(S) to an available SLP as specified above.

In the event of a circuit failure, an SLP reset or SLP disconnection, all multilink frames unacknowledged on an SLP link shall be retransmitted on an operational SLP(s) which is(are) not in the busy condition.

NOTE 2 – The action to be taken on the receipt of an RNR frame by the SLP whose unacknowledged multilink frames have been removed for further study.

NOTE 3 – The means of detecting transmitting MLP malfunctions (e.g., sending more than MW multilink frames) and the actions to be taken are for further study.

2.5.4.4 Receiving multilink frames

Any multilink frame less than two octets in length shall be discarded by the receiving STE.

NOTE 1 – The procedures to be followed by the receiving STE when V and/or S is equal to 1 are for further study.

When the STE receives multilink frames from one of its SLPs, the STE will compare the multilink sequence number MN(S) of the received multilink frame to its multilink receive state variable MV(R), and act on the frame as follows:

a) If the received MN(S) is equal to the current value of MV(R), i.e., is the next expected insequence multilink frame, the MLP delivers the packet to the packet layer.

b) If the MN(S) is greater than the current value of MV(R) but less than [MV(R) + MW + MX], the MLP keeps the received multilink frame until condition a) is met, or discards it if it is a duplicate.

c) If the MN(S) is other than that in a) and b) above, the multilink frame is discarded.

NOTE 2 – In case c) above the recovery from the desynchronization greater than MX between the local and the remote MLP, i.e., the value of MN(S) assigned to new multilink frames at the remote MLP is higher than MV(R) + MW + MX at the local MLP, is for further study.

On receipt of a multilink frame, MV(R) is incremented in the following way:

i) If MN(S) is equal to the current value of MV(R), the MV(R) is incremented by the number of consecutive in-sequence multilink frame received. If additional multilink frames are awaiting delivery pending receipt of a multilink frame with MN(S) equal to MV(R), then Timer MT1 (see 2.5.5.1) is restarted; otherwise MT1 is stopped.

ii) If MN(S) is greater than the current value of MV(R) but less than MV(R) + MW, MV(R) remains unchanged. Timer MT1 is started, if not already running.

iii) If MN(S) is ≥ MV(R) + MW but < MV(R) + MW + MX, MV(R) is incremented to MN(S) – MW + 1 and then the packet layer may be informed of the packet loss at the original value of MV(R). As MV(R) is being incremented, if the multilink frame with MN(S) = MV(R) has not yet been received, the packet layer may be informed of the packet loss also; if the multilink frame with MN(S) = MV(R) has been received, it is delivered to the packet layer. After MV(R) reaches MN(S) – MW + 1, it may then be incremented further as above until the first unacknowledged MN(S) is encountered (see Figure 4).

iv) If the MN(S) is other than that in i), ii) and iii) above, MV(R) remains unchanged.

If Timer MT1 runs out, MV(R) is incremented to MN(S) of the next multilink frame awaiting delivery to the packet layer and then the packet layer may be informed of the packet loss at the original MV(R). The procedure follows i) and a) above as long as there are consecutive in-sequence multilink frames which have been received.

When flow control of the other MLP is desired, one or more SLP(s) may be made to indicate a busy condition. The number of remote SLPs made busy determines the degree of flow control realized.

If the MLP can exhaust its receive buffer capacity before resequencing can be completed, Timer MT2 (see 2.5.5.2) may be implemented. Whenever a busy condition is indicated by the MLP on all its SLPs, and multilink frames at the MLP are awaiting resequencing, Timer MT2 shall be started. When the busy condition is cleared on one or more SLPs by the MLP, Timer MT2 shall be stopped.

If Timer MT2 runs out, the multilink frame with MN(S) = MV(R) is blocked and shall be considered lost. MV(R) shall be incremented to the next sequence number not yet received, and the packets contained in multilink frames with intervening multilink sequence numbers are delivered to the packet layer. Timer MT2 shall be restarted if the busy condition remains in effect on all SLPs and more multilink frames are awaiting resequencing.

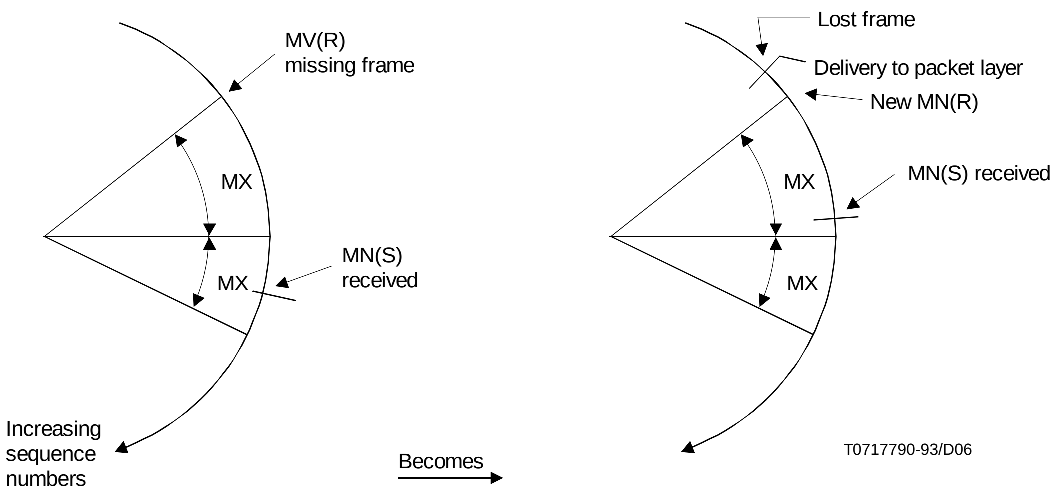


FIGURE 4/X.75

Detecting lost multilink frames

2.5.4.5 Retransmission of multilink frames

If an SLP has retransmitted a multilink frame MN1 times, the STE will then assign the multilink frame to the same or one or more other links, unless the MN(S) has been acknowledged on some previous link. The STE shall always reassign the lowest MN(S) frame first. The first SLP transmits the frame N2 times, regardless of the value of MN1.

NOTE – The procedures associated with the reassigning of multilink frames from a link of poor quality (e.g., before N2 transmissions) to other links are for further study.

2.5.4.6 Taking an SLP out of service

An SLP may be taken out of service for maintenance, traffic, or performance considerations.

An SLP is taken out of service by disconnecting at the physical layer or the data link layer. Any outstanding multilink frames will be treated as in 2.5.4.1. The usual procedure would be to flow control the remote SLP by an RNR, and then to disconnect logically the local SLP (see 2.4.4.3).

If Timer T1 has run out N2 times and the SLP resetting procedure is unsuccessful, then the SLP will enter the disconnected phase, taking the SLP out of service (see 2.4.5.8 and 2.4.7.2).

NOTE – In the case when all SLPs are out of service, the recovery mechanism is based on initiating the MLP reset procedure. Additional recovery procedures are for further study.

2.5.5 List of multilink system parameters

2.5.5.1 Lost-frame timer MT1

Timer MT1 is used at a receiving STE to provide a means to identify during low traffic periods that the multilink frame with MN(S) equal to MV(R) is lost.

2.5.5.2 Group busy timer MT2

Timer MT2 is provided at a receiving STE to identify a "blocked" multilink frame condition (e.g., a buffer exhaust situation) that occurs before required resequencing can be accomplished. MT2 is started when all SLPs are busy and there are multilink frames awaiting resequencing. If MT2 runs out before the "blocked" multilink frame MV(R) is received, the "blocked" multilink frame(s) is(are) declared lost. MV(R) is incremented to the value of the next in-sequence multilink frame to be received, and any packets intervening multilink frames are delivered to the packet layer.

NOTE – MT2 may be set to infinity; e.g., when the receiving STE always has sufficient storage capacity.

2.5.5.3 MLP reset confirmation timer MT3

Timer MT3 is used by the MLP to provide a means of identifying that the remote MLP multilink frame with the C bit set to 1 that is expected following the transmission of the MLP multilink frame with R bit set to 1 has not been received.

2.5.5.4 Retransmission attempts MN1

MN1 has a value between zero and the smallest N2 over all SLPs inclusive. If a multilink frame is to be retransmitted at the SLP sublayer, MN1 retries indicates when action may be taken at the MLP sublayer.

3 Packet layer procedures between signalling terminals

3.0 General principles

Clause 3 of this Recommendation relates to the transfer of packets at the STE-X/STE-Y (X/Y) interface. The procedures apply to packets which are successfully transferred across the X/Y interface.

Each packet to be transferred across the X/Y interface shall be contained within the link layer information field which will delimit its length, and only one packet shall be contained in the information field of an I frame.

NOTE – Some networks require the data field of packets to contain an integral number of octets. The arrangements for interworking with such networks is subject to bilateral agreement between Administrations. The transmission by a DTE of data fields not containing an integral number of octets to the network may cause a loss of data integrity.

To enable simultaneous virtual calls and/or permanent virtual circuits, logical channels are used. Each virtual call and permanent virtual circuit is assigned a logical channel group number (in the range 0 to 15 inclusive) and a logical channel number (in a range of 0 to 255 inclusive). For virtual calls, a logical channel group number and a logical channel number are assigned during the call set-up phase. The range of logical channel and logical channel groups that are available for assignment to virtual calls is agreed bilaterally for a period of time. For permanent virtual circuits using the static method, a logical channel group number and a logical channel number are assigned at the time of establishment (see Recommendation X.181). Procedures for a dynamic method are for further study.

The combination of logical channel number 0 and logical channel group number 0 will not be used for virtual calls and permanent virtual circuits.

In the case that multiple STE X/Y interfaces are used between two networks, virtual calls may be distributed over the available STEs. STE selection may be performed once by the originating and each transit network for a call request. The procedure for selecting the particular X/Y interface is network dependent. During the existence of a particular virtual call, each packet related to that call uses the STEs selected at call set-up.

For permanent virtual circuit, each packet related to that circuit uses the STEs selected at establishment time of the permanent virtual circuit. In the case that multiple X/Y interfaces are used between two networks, bilateral agreement is necessary selecting the specific STE X/Y interface to be used.

In the case that multiple STE X/Y interfaces are used between two networks, the networks may apply network utilities and their parameters either in common or independently to the STE X/Y interfaces.

For virtual calls, it is assumed that the gathering of information required for charging and accounting should normally be the responsibility of the calling Administration (see Recommendation D.10). Other arrangements for gathering information are for further study. For permanent virtual circuit, responsibility of gathering information required for charging and accounting should normally be the source Administration (see Recommendation X.181).

The group of logical channels to be assigned for permanent virtual circuits has to be agreed bilaterally between Administrations.

3.1 Procedures for virtual call set-up and clearing

Virtual calls will be set up and cleared according to the procedures described hereunder. The procedures for calls set-up and clearing are only applicable when a logical channel is in the *packet layer ready* state (r1). In all other r states these procedures are not applicable.

3.1.1 Ready state

If there is no call or call attempt in existence and if call set-up is possible, the logical channel is in the *ready* state (p1), within the *packet layer ready* state (r1).

3.1.2 Call request packet

An STE indicates a call request by transferring a *call request* packet which specifies a logical channel in the *ready* state (pl) across the X/Y interface. The logical channel selected by the calling STE is then in the STE *call request* state (p2/3). If this state persists for more than T31, the calling STE will clear the call. The value of T31 is 200 seconds (see Annex D).

NOTE – In the *call request* packet, bit 7 of the general format identifier (see 4.1.1) may be used in conjunction with the delivery confirmation procedure (see 3.3.4). The bit 7 is conveyed transparently through an STE.

3.1.3 Call connected packet

The called STE will indicate acceptance of the call by the called DTE by transferring across the X/Y interface a *call connected* packet specifying the same logical channel as that of the *call request* packet. This places the specified logical channel in the *flow control ready* state (d1) within the *data transfer* state (p4).The procedure applying to the *data transfer* state is specified in 3.3 below.

NOTE – In the call connected packet, bit 7 of the general format identifier (see 4.1.1) may be used in conjunction with the delivery confirmation procedure (see 3.3.4). This bit 7 is conveyed transparently through an STE.

3.1.4 Call collision

Call collision occurs if STE-X receives a *call request* packet when the logical channel specified is in state p2 or if the STE-Y receives a *call request* packet when the logical channel specified is in state p3. In these cases, both calls shall be cleared. The clearing cause field shall be coded “Network congestion”.

In order to reduce the occurrence of this situation, inverse order testing of logical channels will be used. The *call request* packet of one STE will use the logical channel in the *ready* state with the lowest number; the *call request* packet of the other STE will use the logical channel in the *ready* state with the highest number. Which STE will use the lowest number and which the highest number will be agreed bilaterally.

3.1.5 Clear request packet

An STE may request clearing of a logical channel in any state by transferring across the X/Y interface a *clear request* packet specifying the logical channel. If the STE *clear request* state persists for more than T33, the actions taken by the STE are given in Annex D. The value of T33 is 180 seconds.

The clearing cause field will be coded according to the reason for clearing. Each STE shall be capable of generating the distinct codes for all of the call progress signals specified in Recommendation X.96 for the packet-switched data transmission service.

3.1.6 Clear confirmation packet

When an STE-X or STE-Y (STE X/Y) has received a *clear request* packet, it will free the logical channel, whatever the state of the logical channel except the STE X/Y *clear request* state (p6 or p7 respectively), and transfer across the X/Y interface a *clear confirmation* packet specifying the same logical channel. The logical channel is placed in the *ready* state (p1) within the *packet layer ready* state (r1). The receipt of a *clear confirmation* packet cannot be interpreted as an indication of the remote DTE being cleared.

3.1.7 Clear collision

If a logical channel is in the STE X/Y *clear request* state (p6 or p7 respectively) and the STE X[Y receives a *clear request* packet specifying the same logical channel, this STE will consider the clearing completed and will not transmit a *clear confirmation* packet. This logical channel is now in the *ready* state (p1) within the *packet layer ready* state(r1).

3.2 Procedures for permanent virtual circuit service

Figures B.l and B.3 show the state diagrams which give a definition of events at the packet layer X/Y interface for logical channels assigned for permanent virtual circuits.

For permanent virtual circuits there is no call set-up or clearing. The procedures for the control of packets between STEs while in the *data transfer* state are contained in 3.3.

In case of momentary failure within the network, the STE will reset the permanent virtual circuit as described in 3.4.2, with the cause “Network congestion”, and then will continue to handle data traffic.

If the network has a temporary inability to handle data traffic, the STE shall reset the permanent virtual circuit with the cause “Network out of order”. When the network is again able to handle data traffic, the STE should reset the permanent virtual circuit with the cause “Network operational”.

3.3 Procedure for data and interrupt transfer

The data transfer procedure described below applies independently to each logical channel existing at the X/Y interface.

Normal network operation dictates that user data in *data* packets and interrupt data are all passed transparently, unaltered through the network. The order of bits within these packets is preserved. A packet sequence received by an STE is always delivered as a complete packet sequence.

3.3.1 States for data transfer

Data, interrupt, flow control and reset packets may be transmitted and received by an STE in the *data transfer* state (p4) of the *packet layer ready* state (r1) of a logical channel at the X/Y interface. Only in this state, do the flow control and reset procedures described in 3.4 apply to data transmission on that logical channel to and from the STE. In all other *r* or *p* states the data and interrupt transfer, flow control, and reset procedures are not applicable.

3.3.2 Numbering of data packets

Each data packet transmitted at the X/Y interface for each direction of transmission in a virtual call or permanent virtual circuit is sequentially numbered. This sequential numbering is performed regardless of the layer of data [value of the qualifier (Q) bit].

The sequence numbering scheme of the packets is performed modulo 8 or 128. This modulo is common to all logical channels at the X/Y interface. The packet sequence numbers cycle through the entire range 0 to 7 or 0 to l27 respectively. The selection of modulo 8 or 128 is done by bilateral agreement.

Only *data* packets contain this sequence number called the packet send sequence number P(S).

The first data packet to be transmitted across the X/Y interface for a given direction of data transmission when the logical channel has just entered the *flow control ready* state (d 1), has a packet send sequence number equal to 0.

If an STE receives the first *data* packet with a packet send sequence number not equal to 0 after entering the *flow control ready* state (d1), it will reset the virtual call or permanent virtual circuit indicating the cause “Network congestion”.

3.3.3 Data field length of data packets

The standard maximum data field length is 128 octets (1024 bits) and is provided by all Administrations. In addition for virtual calls, optional maximum data field lengths may be provided on a per call basis by bilateral agreement between Administrations in conjunction with an optional network utility defined in 5.3.5 (see Note). For permanent virtual circuits, optional maximum data field length may be provided on a “per permanent virtual circuit” basis by bilateral agreement between Administrations and could be selected at establishment time. The value selected, in conjunction with the window size selected in 3.4.1.1 has to satisfy the throughput class agreed between networks and end users at establishment time for a specific permanent virtual circuit. The attainable throughput at the STE X/Y interface is limited by the line characteristics and the traffic characteristics of other logical channels at the STE X/Y interface.

The data field length may contain any number of bits from 0 up to the agreed maximum data field length.

If an STE receives a *data* packet having a data field exceeding the maximum data field length, it will reset the virtual call or the permanent virtual circuit indicating the cause "Network congestion".

NOTE – Optional maximum data field lengths may be selected from the following list: 16, 32, 64, 256, 512, 1024, 2048 and 4096 octets.

3.3.4 Delivery confirmation, more data and qualifier bits

The setting of the Delivery confirmation bit (or D bit) is used to indicate whether or not an end-to-end acknowledgement of delivery is required for data being transmitted, this information being provided by means of the packet receive sequence number P(R) (see 3.4.1.2).

A packet sequencing method is provided to enable coherent transmission of data longer than the maximum data field length of *data* packets.

Each complete packet sequence consists of any number (including 0) of full *data* packets (full means that the data field contains the bit number of the maximum data field length) with $M = 1$ and $D = 0$, followed by one other packet of any length up to (and including) the maximum with either $M = 0$ and $D = 0$ or 1, or $M = 1$ and $D = 1$. If an STE receives a packet which is not full, and which has the D bit set to 0 but the M bit set to 1, it will reset the virtual call or the permanent virtual circuit; the resetting cause shall be "Network congestion".

A complete packet sequence may be one of two levels as indicated by the *Qualifier* bit (or Q bit).

The value of the Q bit should not change within a complete packet sequence. If an STE detects that the value of this bit has changed within a packet sequence, it may reset the virtual call or the permanent virtual circuit; the resetting cause shall be "Network congestion".

NOTE – The value of the Q bit in a *data* packet, which follows a *data* packet with either $M = 0$ or both the M and D bits set to 1, may be set independently of the value of the Q bit in the previous packet.

3.3.5 Interrupt procedure

The interrupt procedure allows a DTE to transmit data to the remote DTE, without following the flow control procedure applying to *data* packets between STEs (see 3.4). The interrupt procedure can only apply in the *flow control ready* state (dl) within the *data transfer* state (p4).

The interrupt procedure has no effect on the transfer and flow control procedures applying to the *data* packets on the virtual call or the permanent virtual circuit.

If an STE receives an *interrupt* packet with a user data field longer than 32 octets, the STE should reset the virtual call or the permanent virtual circuit.

An STE conveys an interrupt by transferring across the X/Y interface an *interrupt* packet. The other STE will convey the interrupt confirmation by transferring an *interrupt confirmation* packet.

The receipt of an *interrupt cofirmation* packet indicates that the interrupt has been confirmed by the remote DTE by means of a *DTE interrupt confirmation* packet.

An interrupt packet is conveyed across the X/Y interface at or before the point in the stream of *data* packet at which it was generated by the DTE.

An STE receiving a further *interrupt* packet in the time between receiving one *interrupt* packet and transferring the *interrupt confirmation*, may either discard this *interrupt* packet or reset the virtual call or the permanent virtual circuit.

3.4 Procedures for flow control and for reset

The procedures for flow control of *data* packets and for reset only apply to the *data transfer* state (p4) and are specified below.

3.4.1 Procedure for flow control

At the X/Y interface of each logical channel used for a virtual call or a permanent virtual circuit, the transmission of *data* packets is controlled separately for each direction and is based on authorizations from the receiver.

3.4.1.1 Window description

At the X/Y interface of each logical channel used for a virtual call or a permanent virtual circuit, a window is defined for each direction of data transmission as the ordered set of W consecutive packet send sequence numbers of the *data* packets authorized to cross the interface.

The lowest sequence number in the window is referred to as the lower window edge. When a virtual call or a permanent virtual circuit at the X/Y interface has just been established or reset, the window related to each direction of data transmission has a lower window edge equal to 0. The packet send sequence number of the first *data* packet not authorized to cross the interface is the value of the lower window edge plus W (modulo 8 or 128).

The maximum value of the window size for each direction of transmission at the X/Y interface is common to all the logical channels and is agreed for a period of time bilaterally. This value does not exceed 7 or 127 (modulo 8 or 128).

For a particular virtual call or a permanent virtual circuit two window sizes maybe selected, one for each direction of transmission. These window sizes may be less than or equal to the above-mentioned maximum. For virtual calls, the two sizes are selected by reference to a utility (see 5.3.4) in the network utility field of the *call request* packet and the *call connected* packet, and, in some cases, by reference also to a correspondence table relating window size to throughput class. This table is agreed for a period of time between Administrations. For permanent virtual circuits two window sizes are selected at the establishment time and agreed between Administrations. The values selected in conjunction with the data field length selected in 3.3.3 has to satisfy the throughput class agreed between networks and end users at establishment time for a specific permanent virtual circuit. The attainable throughput at the STE X/Y interface is limited by the line characteristics and the traffic characteristics of other logical channels at the STE X/Y interface.

3.4.1.2 Flow control principles

A number modulo 8 or 128 referred to as a packet receive sequence number P(R), conveys across the X/Y interface information from the receiver for the transmission of *data* packets. When transmitted across the X/Y inter-face, a P(R) becomes the lower window edge. In this way, additional *data* packets may be authorized by the receiver to cross the X/Y interface.

When the sequence number P(S) of the next *data* packet to be transmitted by the STE is within the window, the STE is authorized to transmit this *data* packet to the other STE, which may then accept it. When the sequence number P(S) of the next *data* packet to be transmitted by the STE is outside the window, the STE shall not transmit a *data* packet to the other STE. Otherwise, the other STE will consider the receipt of this *data* packet as a procedure error and will reset the virtual call or the permanent virtual circuit.

The packet receive sequence number, P(R), is conveyed in *data, receive ready* (RR) and *receive not ready* (RNR) packets, and implies that the STE transmitting the P(R) has accepted at least all *data* packets numbered up to and including [P(R) – 1].

The value of a P(R) received by the STE must be within the range starting from the last P(R) received by the STE up to and including the packet send sequence number of the next *data* packet to be transmitted by the STE. Otherwise, the STE will consider the receipt of this P(R) as a procedure error and will reset the virtual call or the permanent virtual circuit.

When the D bit is set to 0 in a *data* packet [P(S) = p], the significance of the P(R) [i.e., P(R) p + 1] corresponding to that *data* packet is a local updating of the window across the packet layer interface.

When the D bit is set to 1 in a *data* packet [P(S) = p], the significance of the P(R) received corresponding to the *data* packet [i.e., P(R) p + 1] is an indication that a P(R) has been received from the remote DTE for all data bits in the *data* packet in which the D bit had originally been set to 1 [i.e., P(S) = p].

NOTES

1 The STE is required to send a P(R) corresponding to a *data* packet with the D bit set to 1 as soon as possible after it receives the P(R) from the remote DTE. An *RNR* packet may be used in this case if necessary.

2 In the case where a P(R) for a *data* packet with the D bit set to 1 is outstanding, local updating of the window will be deferred for subsequent data packets with the D bit set to 0. Some STEs may also defer updating of the window for previous *data* packets (within the window) with the D bit set to 0.

3.4.1.3 STE receive ready (RR) packet

RR packets are used by the STE to indicate that it is ready to receive the W *data* packets within the window starting with P(R), where P(R) is indicated in the *RR* packet.

3.4.1.4 STE receive not ready (RNR) packet

RNR packets are used by the STE to indicate a temporary inability to accept additional *data* packets for the virtual call or the permanent virtual circuit. An STE receiving an *RNR* packet shall stop transmitting *data* packets on the indicated logical channel but the window is updated by the P(R) indicated in the *RNR* packet.

The receive not ready situation indicated by the transmission of an *RNR* packet is cleared by the transmission in the same direction of an *RR* packet or by a reset procedure being initiated.

The transmission of an *RR* after an *RNR* at the packet layer is not to be taken as a demand for retransmission of packets which have already been transmitted.

3.4.2 Procedure for reset

The reset procedure is used to reinitialize the virtual call or the permanent virtual circuit. The reset procedure only applies in the *data transfer* state (p4) of the X/Y interface. In any other state of the interface the reset procedure is not applicable.

There are three states within the *data transfer* state (p4). They are *flow control ready* (d1), *STE-X reset request* (d2) and *STE-Y reset request* (d3). When entering state p4, the logical channel is placed in state d1.

When a virtual call or a permanent virtual circuit at the X/Y interface has just been reset, the window related to each direction of data transmission has a lower window edge equal to 0, and the numbering of subsequent *data* packets to cross the X/Y interface for each direction of data transmission shall start from 0.

3.4.2.1 Reset request packet

The STE shall indicate a request for reset by transmitting a *reset request* packet specifying the logical channel. This places the logical channel in the *reset request* state (d2 or d3).

In this state, the STE will discard *data*, *interrupt*, *RR* and *RNR* packets.

3.4.2.2 Reset collision

Reset collision occurs when both STEs simultaneously transfer a *reset request* packet. In this case both STEs shall consider that resetting is complete and shall not transfer a *reset confirmation* packet. The logical channel is then in the *flow control ready* state (d1).

3.4.2.3 Reset confirmation packet

When the logical channel is in the *reset request* state, the requested STE will confirm reset by transmitting to the requesting STE a *reset confirmation* packet. This places the logical channel in the *flow control ready* state (d1).

The reset confirmation packet can only be interpreted universally as having local significance; however, within some Administrations' networks, reset confirmation may have end-to-end significance. If the *reset request* state persists for more than T32, the actions taken by the STE are given in Annex D. The value of T32 is 180 seconds.

3.4.2.4 Effect of reset procedure on data and interrupt packets

Data and *interrupt* packets, transmitted by an STE before a reset procedure is initiated at its X/Y interface, will either be delivered before the corresponding reset procedure is initiated at the remote DTE/DCE interface, or discarded.

The first *data* and *interrupt* packets transmitted by an STE after a reset procedure is completed at its interface will be the first packets delivered after the corresponding reset procedure is completed at the remote DTE/DCE interface.

Data and *interrupt* packets transmitted by an STE after a reset procedure has been initiated by the other STE will be discarded by the latter STE until the reset procedure has been completed at the X/Y interference.

3.5 Procedure for restart

The restart procedure is used to clear simultaneously all the virtual calls and/or reset all the permanent virtual circuits at the X/Y interface.

There are three states of the X/Y interface concerned with the restart procedure. They are *packet layer ready* (r1), *STE-X restart request* (r2) and *STE-Y restart request* (r3). When entering state r1, all logical channels are placed in state p1.

3.5.1 Restart by the STE

The STE may at any time request a restart by transfering across the X/Y interface a *restart request* packet. The interface for each logical channel is then in the *request* state (r2 or r3).

In this state of the X/Y interface, the STE will discard all packet types except *restart request* and *restart confirmation* packets.

On receipt of a *restart request* packet, an STE shall clear all virtual calls and reset all permanent virtual circuits and shall place logical channels used for virtual calls in the *ready* state (pl) and the logical channels used for permanent virtual circuits in the *flow control ready* state (dl). The STE shall return a *restart confirmation* packet unless a collision has occurred.

The restart confirmation packet can only be interpreted universally as having local significance. If *the restart request* state persists for more than T30, the actions taken by the STE are given in Annex D. The value of T30 is 180 seconds.

3.5.2 Restart collision

Restart collision can occur when both STEs simultaneously transfer *restart request* packets. Under these circumstances, both STEs will consider that the restart is completed and will not expect a *restart confirmation* packet, neither will they transfer a *restart confirmation* packet.

3.6 Relationship between layers

Changes of operational states of the physical and link layer of the X/Y interface do not implicitly change the state of each logical channel at the packet layer. Such changes, when they occur, are explicitly indicated at the packet layer by the use of restart, clear or reset procedures as appropriate.

However, in some cases of trouble at the link layer, it may be appropriate to initiate the restart procedure, and accept no more new virtual calls or no more data packets on permanent virtual circuits.

A failure on the physical and/or link layer is defined as a condition in which the STE cannot transmit and receive any frames because of abnormal conditions caused by, for instance, a line fault between STEs.

When a failure on the physical and/or link layer is detected, virtual calls will be cleared and permanent virtual circuits will be declared out of order. The STE will transmit to the remote end in the network:

1) a reset with the cause “Network out of order” and the appropriate diagnostic for each permanent virtual circuit; and

2) a clear with the cause “Network congestion” and the appropriate diagnostic for each existing virtual call.

During the failure:

1) the STE will clear any virtual call with the cause “Network congestion” and an appropriate diagnostic;

2) for any *data* or *interrupt* packet received from the remote DTE on a permanent virtual circuit, the STE will reset the permanent virtual circuit with the cause “Network out of order” and an appropriate diagnostic;

3) a *reset request* packet received from the remote end on a permanent virtual circuit will be confirmed to the remote end by either a *reset confirmation* or *reset request* packet.

The appropriate diagnostic value depends on whether the failure was unexpected or the result of planned maintenance action; the values are No. 115 and No. 122 respectively (see also Note 3 of Annex E).

When the failure is recovered on the physical and link layers, the restart procedure will be actioned with the cause “Network operation” and a reset with the cause “Network operational” will be transmitted to both ends of each permanent virtual circuit going through the X/Y interface.

In other out-of-order conditions on the physical and/or link layer, the STE will clear virtual calls and reset permanent virtual circuits.

4 Packet formats for virtual calls and permanent virtual circuits

4.1 General

The formats of Recommendation X.75 packets are based on the general structure of packets in Recommendation X.25. It is anticipated that modification in Recommendation X.25 control packet formats will also be adopted in this Recommendation.

The possible extension of packet formats by the addition of new fields is for further study.

Bits of an octet are numbered 8 to 1 where bit 1 is the low order bit and is transmitted first. Octets of a packet are consecutively numbered starting from 1 and are transmitted in this order.

4.1.1 General format identifier

The general format identifier field is a four-bit binary coded field which is provided to indicate the general format of the rest of the header. The general format identifier field is located in bit positions 8, 7, 6 and 5 of octet 1 and 5 is the low order bit (see Table 11).

Bit 8 of the general format identifier is used for the qualifier (Q) in *data* packets and is set to 0 in all other packet types.

Bit 7 of the general format identifier is used in *data* and in *call set-up* packets in conjunctions with the *delivery confirmation* (D) procedure, and is set to 0 in all other packet types.

Bits 5 and 6 are encoded for four possible indications. Two of the codes are used to distinguish packets using modulo 8 sequence numbering scheme from packets using modulo 128 sequence numbering scheme. The third code is used to indicate an extension to an extended family of general format identifier codes and extended formats which are a subject for further study. The fourth code is unassigned.

4.1.2 Logical channel group number

The logical channel group number appears in every packet except in *restart* packets (see 4.5) in bit positions 4, 3, 2 and 1 of octet 1. This field is binary coded and bit 1 is the low order bit of the logical channel group number.

For each logical channel, this number has local significance at the X/Y interface.

4.1.3 Logical channel number

The logical channel number appears in every packet except in *restart* packets (see 4.5) in all bit positions of octet 2. This field is binary coded and bit 1 is the low order bit of the logical channel number.

For each logical channel, this number has local significance at the X/Y interface.

TABLE 11/X.75

General format identifier

General format identifier		Octet 1 Bits 8	7	6	5
Data packets	Sequencing numbers scheme modulo 8	X	X	0	1
	Sequencing numbering scheme modulo 128	X	X	1	0
Call set-up packets	Sequencing numbering scheme modulo 8	0	X	0	1
	Sequencing numbering scheme modulo 128	0	X	1	0
Clearing, flow control interrupt, reset and restart packets	Sequencing numbering scheme modulo 8	0	0	0	1
	Sequencing numbering scheme modulo 128	0	0	1	0
General format identifier extension		U	U	1	1
Reserved format for other applications		U	U	0	0
NOTE – A bit which is indicated as X may be set to either 0 or 1 as specified in the text and in Figures 3, 4, 7 and 8. A bit which is indicated as U is unspecified.					

4.1.4 Packet type identifier

Each packet shall be identifier in octet 3 of the packet according to Table 12.

4.2 Call set-up and clearing packets

The following describes the nature of addresses present in the call set-up and clearing packets.

If the STE X/Y interface is between two PSPDNs, or between a PSPDN and an ISDN then the addresses will be in the international format given in Recommendation X.121, including escape digits where required. If the STE X/Y interface is between two ISDNs, then the addresses will be in the international format given in Recommendation E.164, including escape digits where required. Additional guidance is given in Recommendations X.31, X.122 and E.166.

NOTE 1 – All STEs should support a calling DTE address of the formats:

– 9/0 + E.164 CountryCode, and DNIC assigned to a PSN,

corresponding to the incomplete X.121 PSN format described in 3.1.3.1/X.32. The minimum valid address length of this format is two digits.

The maximum length of a call set-up/clearing packet is 323 octects. All fields except the network utilities and user facilities fields have maxima as given in the following clauses. The network utilities and user facilities fields may vary in size up to values so as to make the packet no greater than 323 octets in length. If the 323 octet packet size constraint is violated, the call is cleared with cause “Network Congestion” and diagnostic #39 (“Packet too long”). If any of the field-specific maxima is exceeded, the call is cleared with the appropriate cause and diagnostic code, as specified in Annex F.

An STE should have a capability such that if the STE at the other end of the interface is known to support only the procedures based on the 1988 or earlier versions of Recommendations X.75, the new STE should maintain backward compatibility with respect to network utility and user facility lengths by behaving as per the 1988 version of Recommendations X.75.

Note 2 – Although a call set-up/clearing packet does not exceed 323 octets when transmitted across the local STE X/Y interface, it still may not be compatible in size with all X.75 interfaces en route to the remote DTE. This is true if, for example, facilities and utilities are added to the packet. In such cases, the call is cleared with the appropriate cause and diagnostic codes as specified above.

TABLE 12/X.75

Packet type identifier

Packet Type	Octet 3 Bits							
	8	7	6	5	4	3	2	1
Call set-up clearing								
Call request	0	0	0	0	1	0	1	1
Call connected	0	0	0	0	1	1	1	1
Clear request	0	0	0	1	0	0	1	1
Clear confirmation	0	0	0	1	0	1	1	1
Data and interrupt								
Data	X	X	X	X	X	X	X	0
Interrupt	0	0	1	0	0	0	1	1
Interrupt confirmation	0	0	1	0	0	1	1	1
Flow control and reset								
Receive ready (modulo 128)	0	0	0	0	0	0	0	1
Receive ready (modulo 8)	X	X	X	0	0	0	0	1
Ready not ready (modulo 128)	0	0	0	0	0	1	0	1
Ready not ready (modulo 8)	X	X	X	0	0	1	0	1
Reset request	0	0	0	1	1	0	1	1
Reset confirmation	0	0	0	1	1	1	1	1
Restart								
Restart request	1	1	1	1	1	0	1	1
Restart confirmation	1	1	1	1	1	1	1	1

NOTE – A bit which is indicated as X may be set to either 0 to 1 as specified in the text and in Figures 5 to 20.

4.2.1 Call request packet

Figure 5 illustrates the format of a *call request* packet. In this figure the user facility length field, user facilities field, and call user data field are as defined in Recommendation X.25.

4.2.1.1 General format identifier

Bit 7 can be set to either 0 or 1.

4.2.1.2 Address length field

Octet 4 consists of field length indicators for the called and calling DTE address. Bits 4, 3, 2 and 1 indicate the length of the called DTE address in semi-octets. Bits 8, 7, 6 and 5 indicate the length of the calling DTE address in semi-octets. Each address length indicator is binary coded and bit 1 or 5 is the low order bit of the indicator.

4.2.1.3 Address field

Octet 5 and the following octets consist of the called DTE address followed by the calling DTE address as specified in 4.2.

Number of octets	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note 1)				Logical channel group number			
1	Logical channel number							
1	Packet type identifier							
	0	0	0	0	1	0	1	1
1	Calling DTE address length				Called DTE address length			
15 (max.)	Called and calling DTEs addresses							
1	0	0	Network utility length					
(Note 3)	Network utilities							
1	0	User facility length						
(Note 3)	Network facilities							
16 (max.) or 128 (max.)	Call user data (see Note 2)							

NOTES

1 Coded 0D01 (modulo 8) or 0D10 (modulo 128). D is the delivery confirmation bit.

2 More than 16 octets of call user data will only be present when the *fast select* utility present in the call request packet.

3 There is no separate maximum size for the network utilities or user facilities field. However, the total packet size cannot exceed 323 octets.

FIGURE 5/X.75

Call request packet format

Each digit of an address is coded in a semi-octet in binary coded decimal with bit 5 or 1 being the low order bit of the digit.

Starting from the high order digit, the address is coded in octet 5 and consecutive octets with two digits per octet. In each octet, the higher order digit is coded in bits 8, 7, 6 and 5.

The address field shall be rounded up to an integral number of octets by inserting 0s in bits 4, 3, 2 and 1 of the last octet of the field when necessary.

4.2.1.4 Network utility length field

Bits 8 through 1 of the octet following the address field indicate the length of the network utility field in octets.

The network utility length field indicator is binary coded and bit 1 is the low order bit.

4.2.1.5 Network utility field

The network utility field contains an integral number of octets. The length of this field depends on the utilities present.

The coding of the network utilitz field is defined in 5 below.

4.2.1.6 User facility length field

Bits 8 through 1 of the octet following the network utility field indicate the length of the user facility field in octets. The user facility length indicator is binary coded and bit 1 is the low order bit.

4.2.1.7 User facility field

The user facility field contains an integral number of octets. The length of this field depends on the facilities present. The coding of the user facility field is dependent on the facilities being requested as defined in Table 7-2/X.25 and Annex G/X.25.

4.2.1.8 Call user data field

Following the user facility field, user data may be present. In the absence of the fast select utility, the call user data field may contain any number of bits from 0 to 128 (16 octets). When the fast select utility is present, the call user data may contain any number of bits from 0 to 1024 (128 octets). The contents of the field are passed unchanged.

The call user data field of a call request packet that is constructed as a result of inter-network call redirection/deflection contains the same user data passed back in the clear request packet with call redirection/deflection.

NOTE – Some networks require the call user data field to contain an integral number of octets (see Note in clause 3).

4.2.2 Call connected packet

Figure 6 illustrates the format of a *call connected* packet. Similarly to the *call request* packet, the *call connected* packet contains:

- an address length field;
- an address field;
- a network utility length field;
- a network utility field;
- a user facility length field;
- a user facility field; and
- a called user data field.

The coding of these fields is the same as that in *call request* packet (see 4.2.1). Bit 7 of the general format identifier can be set to either 0 or 1. The address field may be empty. However, in the case of call redirection, the address field shall contain the address of the DTE to which the call was finally directed, and the utility field should contain the *called line address modified notification* utility (see 5.3.10).

The called user data field may only be included for call in which the fast select utility was present in the call request packet indicating no restriction on response and may contain any number of bits from 0 up to 1024 (128 octets). The contents of the field are passed unchanged.

4.2.3 Clear request packet

Figure 7 illustrates the format of a *clear request* packet.

Number of octets	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note 1)				Logical channel group number			
1	Logical channel number							
1	Packet type identifier							
	0	0	0	0	1	1	1	1
1	Calling DTE address length				Called DTE address length			
15 (max.)	Called and calling DTEs addresses							
1	0	0	Network utility length					
(Note 3)	Network utilities							
1	0	User facility length						
(Note 3)	User facilities							
128 (max.)	Call user data (see Note 2)							

NOTES

1 Coded 0D01 (modulo 8) or 0D10 (modulo 128). D is the delivery confirmation bit.

2 This field will only be included where the called user data is returned in response to a *call request* packet in which the *fast select* utility was present indicating no restriction on response.

3 There is no separate maximum size for the network utilities or user facilities field. However, the total packet size cannot exceed 323 octets.

FIGURE 6/X.75

Call connected packet format

4.2.3.1 Clearing cause field

Octet 4 is the clearing cause field and contains the reason for the clearing of the call.

The coding of the clearing cause field in a *clear request* packet is given in Table 13.

An STE receiving a clearing cause other than that given in Table 13 will either pass this cause unchanged or change the cause to “Network congestion”.

4.2.3.2 Diagnostic code field

Octet 5 is the diagnostic code field and may contain additional information on the reason for the clearing of the call.

If the associated clearing cause field (octet 4) indicates any valid cause (see Table 13) except “Network congestion”, the contents of this field will be passed unchanged. If the clearing cause field indicates “Network congestion” and the original clear or restart request was generated as the result of an event detected other than at the local STE-X/Y interface, then the value of the diagnostic code passed will be as shown in Table 14.

The diagnostic codes in *clear request* packets generated as the result of event detected at the local STE-X/Y interface are listed in Annex E.

	Bits								
Number of octets	8	7	6	5	4	3	2	1	
1	General format identifier (see Note 1)				Logical channel group number				
1	Logical channel number								
1	Packet type identifier								
	0	0	0	1	0	0	1	1	
1	Clearing-cause								
1	Diagnostic code								
1	Calling DTE address length				Called DTE address length				
15 (max.)	Called and calling DTEs addresses								(See Note 3)
1	0	0	Network utility length						
(Note 4)	Network utilities								
1	0	User facility length							
(Note 4)	User facilities								
128 (max.)	Call user data (see Note 2)								

NOTES

1 Coded 0001 (modulo 8) or 0010 (modulo 128).

2 This field will only be included where the clear user data is returned when the *fast select* utility was present in the *call request* packet.

3 Used only in the extended format (see 4.2.3.3).

4 There is no separate maximum size for the network utilities or user facilities field. However, the total packet size cannot exceed 323 octets.

FIGURE 7/X.75

Clear request packet format

TABLE 13/X.75

Coding of clearing cause field in a clear request packet

Clearing cause	Octet 4 Bits							
	8	7	6	5	4	3	2	1
DTE originated	0	0	0	0	0	0	0	0
DTE originated (see Note 1)	1	X	X	X	X	X	X	X
Number busy	0	0	0	0	0	0	0	1
Out of order	0	0	0	0	1	0	0	1
Remote procedure error	0	0	0	1	0	0	0	1
Reverse charging acceptance not subscribed	0	0	0	1	1	0	0	1
Incompatible destination	0	0	1	0	0	0	0	1
Fast select acceptance not subscribed	0	0	1	0	1	0	0	1
Ship absent (see Note 2)	0	0	1	1	1	0	0	1
Invalid facility request	0	0	0	0	0	0	1	1
Access barred	0	0	0	0	1	0	1	1
Network congestion	0	0	0	0	0	1	0	1
Not obtainable	0	0	0	0	1	1	0	1
ROA problem (see Note 3)	0	0	0	1	0	1	0	1

NOTES

1 When bit 8 is set to 1, the bits represented by Xs are those included by the remote DTE in the clearing or restarting clause field of the X.25 *clear* or *restart request* packet.

2 Used in conjunction with Mobile Maritime service.

3 May be received by the STE only if the optional ROA *selection* utility was used by the STE.

TABLE 14/X.75

Diagnostic code mapping for clear request packet

Decimal value originally generated	Decimal value passed
0	Same
1 to 111	114
112 to 127	Same
128 to 255	113

4.2.3.3 Extended format

The following fields may follow the diagnostic code field in the extended format:

- an address length field;
- an address field;
- a network utility length field;
- a network utility field;
- a user facility length field;
- a user facility field; and
- a clear user data field.

4.2.3.3.1 Address length field

This single octet field consists of field length indicators for the called and calling DTE addresses. Bits 4, 3, 2 and 1 indicate the length of the called DTE address in semi-octets. Bits 8, 7, 6 and 5 indicate the length of the calling DTE address in semi-octets. Each address length indicator is binary coded and bit 1 or 5 is the low order bit of the indicator.

The address length field is always present when the network utility length field is present.

4.2.3.3.2 Address field

In the case that the clear request is issued, by a DTE to which a call has been redirected or deflected, as a direct response to the *call request* packet the address shall contain the address of the DTE to which the call was finally directed. In the case that the clear request is issued to indicate to the network that originated the call request that the call is to be redirected or deflected, the address field shall contain the address of the DTE which redirected or deflected the call. Other use of this field is for further study.

NOTE – In the case of call redirection or call distribution within a hunt group, the utility field of *clear request* packet should include the *called line address modified notification* utility (see 5.3.10) if the clear request packet was issued by the DTE to which the call was finally directed.

4.2.3.3.3 Network utility length field

Bits 8 through 1 of the octet following the address field indicate the length of the network utility field in octets.

The network utility length field is binary coded and bit 1 is the low order bit.

The network utility length field is always present when the user facility length is present.

4.2.3.3.4 Network utility field

The network utility field contains an integral number of octets. The length of this field depends on the utilities present.

The coding of the network utility field is defined in 5 below.

4.2.3.3.5 User facility length field

Bits 8 through 1 of the octet following the network utility field indicate the length of the user facility field in octets. The user facility length indicator is binary coded and bit 1 is the low order bit of the indicator.

The user facility length field is always present when the user data field is present.

4.2.3.3.6 User facility field

The user facility field contains an integral number of octets. The length of this field depends on the facilities present. The coding of the user facility field is dependent on the facilities being requested as defined in Table 29/X.25 and Annex G/X.25.

4.2.3.3.7 Clear user data field

For calls in which the *fast select* utility was present, clear user data may be present, following the user facility field. The clear user data field may contain any number of bits from 0 up to 1024 (128 octets). The contents of the field are passed unchanged.

NOTE – Some networks require the clear user data field to contain an integral number of octets (see Note in clause 3).

4.2.4 Clear confirmation packet

Figure 8 illustrates the format of the clear *confirmation* packet.

	Bits							
	8	7	6	5	4	3	2	1
Octets 1	General format identifier (see Note)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier							
	0	0	0	1	0	1	1	1

NOTE – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 8/X.75

Clear confirmation packet format

4.3 Data and interrupt packets

4.3.1 Data packet

Figures 9 and 10 illustrate the format of the *data* packets in the case of modulo 8 and modulo 128 respectively.

4.3.1.1 Qualifier (Q) bit

Bit 8 in octet 1 is used for the *qualifier* (Q) bit.

4.3.1.2 Delivery confirmation (D) bit

Bit 7 in octet 1 is the *delivery confirmation* (D) bit.

4.3.1.3 Packet receive sequence number

In Figure 9 bits 8, 7 and 6 of the octet 3 are used for indicating the packet receive sequence number P(R) is binary coded and bit 6 is the low order bit. In Figure 10, bits 2 through 8 of octet 4 are used for the packet send sequence number and bit 2 is the low order bit.

Bits

Octets	8	7	6	5	4	3	2	1
1	General format identifier				Logical channel group number			
	Q	D	0	1				
2	Logical channel number							
3	P(R)			M	P(S)			0
	User data							

D Delivery confirmation
M More data indication
Q Qualifier

FIGURE 9/X.75

Data packet format (modulo 8)

Bits

Octets	8	7	6	5	4	3	2	1
1	General format identifier				Logical channel group number			
	Q	D	1	0				
2	Logical channel number							
3	P(S)							0
4	P(R)							M
	User data							

D Delivery confirmation
M More data bit
Q Qualifier bit

FIGURE 10/X.75

Data packet format (modulo 128)

4.3.1.4 More data bit

In Figure 9, bit 5 in octet 3 is used for the *more data* mark (M bit). In Figure 10, bit 1 in octet 4 is used for the *more data* mark (M bit) (0 for no more data and 1 for more data).

4.3.1.5 Packet send sequence number

In Figure 9, bits 4, 3 and 2 of octet 3 are used for indicating the packet send sequence number P(S). P(S) is binary coded and bit 2 is the low order bit. In Figure 10, bits 2 through 8 of octet 3 are used for the packet send sequence number and bit 2 is the low order bit.

4.3.1.6 User data field

The bits following octet 3 (modulo 8) or octet 4 (modulo 128) contain user data.

NOTE – Some networks require the user data field to contain an integral number of octets (see Note in clause 3).

4.3.2 Interrupt packet

Figure 11 illustrates the format of the *interrupt* packet.

Bits

Octets	8	7	6	5	4	3	2	1
1	General format identifier (see Note)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier							
	0	0	1	0	0	0	1	1
32 (max.)	Interrupt user data							

NOTE – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 11/X.75

Interrupt packet format

4.3.2.1 Interrupt user data field

Octet 4 and any following octets contain the interrupt user data. This field contains from 1 to 32 octets.

NOTE – Some networks require the interrupt user data field to contain an integral number of octets (see Note in clause 3).

4.3.3 Interrupt confirmation packet

Figure 12 illustrates the format of the *interrupt confirmation* packet.

4.4 Flow control and reset packets

4.4.1 Receive ready (RR) packet

Figures 13 and 14 illustrate the format of receive ready packets in the case of modulo 8 and modulo 128 respectively.

4.4.1.1 Packet receive sequence number

In Figure 13, bits 8, 7 and 6 of octet 3 are used for indicating the packet receive sequence number P(R). P(R) is binary coded and bit 6 is the low order bit. In Figure 14, bits 2 through 8 of octet 4 are used for the packet receive sequence number and bit 2 is the low order bit.

	Bits							
	8	7	6	5	4	3	2	1
1	General format identifier (see Note)				Logical channel group number			
Octets 2	Logical channel number							
	Packet type identifier							
3	0	0	1	0	0	1	1	1

NOTE – Coded 0001 (modulo 8) or 0010 (modulo 128)

FIGURE 12/X.75

Interrup confirmation packet format

	Bits							
	8	7	6	5	4	3	2	1
1	General format identifier				Logical channel group number			
	0	0	0	1				
Octets 2	Logical channel number							
3	P(R)			Packet type identifier				
				0	0	0	0	1

FIGURE 13/X.75

RR packet format (modulo 8)

4.4.2 Receive not ready (RNR) packet

Figures 15 and 16 illustrate the format of *receive not ready* packets in the case of modulo 8 and modulo 128 respectively.

4.4.2.1 Packet receive sequence number

In Figure 15, bits 8, 7 and 6 of octet 3 are used for indicating the packet receive sequence number P(R). P(R) is binary coded and bit 6 is the low order bit. In Figure 16, bits 2 through 8 of octet 4 are used for the packet receive sequence number and bit 2 is the low order bit.

4.4.3 Reset request packet

Figure 17 illustrates the format of the *reset request* packet.

	Bits							
	8	7	6	5	4	3	2	1
1	General format identifier				Logical channel group number			
	0	0	1	0				
Octets 2	Logical channel number							
3	Packet type identifier							
	0	0	0	0	0	0	0	1
4	P(R)							0

FIGURE 14/X.75

RR packet format (modulo 128)

	Bits							
	8	7	6	5	4	3	2	1
1	General format identifier				Logical channel group number			
	0	0	0	1				
Octets 2	Logical channel number							
3	P(R)			Packet type identifier				
				0	0	1	0	1

FIGURE 15/X.75

RNR packet format (modulo 8)

4.4.3.1 Resetting cause field

Octet 4 is the resetting cause field and contains the reason for the reset.

The coding of the resetting cause field in a *reset request* packet is given in Table 15.

An STE receiving a resetting cause other than that given in Table 15 will either pass this cause unchanged or change the cause to "Network congestion".

4.4.3.2 Diagnostic code field

Octet 5 is the diagnostic code field and may contain additional information on the reason for the reset.

If the associated resetting cause field (octet 4) indicates any valid cause (see Table 15) except “Network congestion”, the contents of this field will be passed unchanged. If the resetting cause field indicates “Network congestion” and the original reset or restarting request was generates as the result of an event detected other than at the local STE-X/Y interface, then the value of the diagnostic code passed will be as shown in Table 16.

The diagnostic codes in *reset request* packets generated as the result of events detected at the local STE-X/Y interface are listed in Annex E.

Bits

Octets	8	7	6	5	4	3	2	1
1	General format identifier				Logical channel group number			
	0	0	1	0				
2	Logical channel number							
3	Packet type identifier							
	0	0	0	0	0	1	0	1
4	P(R)							0

FIGURE 16/X.75

RNR packet format (modulo 128)

Bits

Octets	8	7	6	5	4	3	2	1
1	General format identifier (see Note)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier							
	0	0	0	1	1	0	1	1
4	Resetting cause							
5	Diagnostic code							

NOTE – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 17/X.75

Reset request packet format

TABLE 15/X.75

Coding of resetting cause field in reset request packet

Resetting cause	Octet 4 Bits							
	8	7	6	5	4	3	2	1
DTE originated	0	0	0	0	0	0	0	0
DTE originated (see Note 1)	1	X	X	X	X	X	X	X
Out of order (see Note 2)	0	0	0	0	0	0	0	1
Remote procedure error	0	0	0	0	0	0	1	1
Network congestion	0	0	0	0	0	1	1	1
Remote DTE operational (see Note 2)	0	0	0	0	1	0	0	1
Network operational (see Note 3)	0	0	0	0	1	1	1	1
Incompatible destination	0	0	0	1	0	0	0	1
Network out of order (see Note 2)	0	0	0	1	1	1	0	1

NOTES

1 When bit 8 is set to 1, the bits represented by Xs are those indicated by the remote DTE int the resetting cause field (virtual calls and permanent virtual circuits) or the restarting cause field (permanent virtual circuits) of the X.25 *reset* or *restart request* packets.

2 Applicable to permanent virtual circuits only.

3 If the STE receives a *reset request* packet with the cause "Network operational", it does not necessarily mean that the permanent virtual circuit is operational.

TABLE 16/X.75

Diagnostic codes mapping for reset request packet

Decimal value originally generated	Decimal value passed
0	Same
1 to 111	114
112 to 127	Same
128 to 255	113

4.4.4 Reset confirmation packet

Figure 18 illustrates the format of the *reset confirmation* packet.

Octets	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier							
	0	0	0	1	1	1	1	1

NOTE – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 18/X.75

Reset confirmation packet format

4.5 Restart packets

4.5.1 Restart request packet

Figure 19 illustrates the format of the *restart request* packet. Bits 4, 3, 2 and 1 of the first octet and all bits of the second octet are set to 0.

Octets	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note)				0	0	0	0
2	0	0	0	0	0	0	0	0
	Packet type identifier							
3	1	1	1	1	1	0	1	1
4	Restarting cause							
5	Diagnostic code							

NOTE – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 19/X.75

Restart request packet format

4.5.1.1 Restarting cause field

Octet 4 is the restarting cause field and contains the reason for the restart.

The coding of the restarting cause field in the *restart request* packets is given in Table 17.

An STE receiving a restarting cause other than that given in Table 17 will either pass this cause unchanged or change the cause to "Network congestion".

TABLE 17/X.75

Coding of restarting cause field in restart request packet

Restarting cause	Octet 4 Bits							
	8	7	6	5	4	3	2	1
Network congestion	0	0	0	0	0	0	1	1
Network operational	0	0	0	0	0	1	1	1

4.5.1.2 Diagnostic code field

Octet 5 is the diagnostic code field and may contain additional information on the reason for the restart.

If the associated restarting cause field (octet 4) indicates any valid cause (see Table 17) except "Network congestion", the contents of this field will be passed unchanged in the resulting *clear* or *reset request* packet. If the restarting cause field indicates "Network congestion" then the value of the diagnostic code sent in the resulting *clear* or *reset request* packet will be as shown in Table 18.

TABLE 18/X.75

Diagnostic code mapping for restart request packet

Decimal value originally generated	Decimal value sent
0	Same
1 to 111	114
112 to 127	Same
128 to 255	113

The diagnostic codes in *restart request* packets generated as the result of events detected at the local STE-X/Y interface are listed in Annex E.

The bits of the diagnostic code field are all set to 0 when no specific reason for the restart is supplied.

4.5.2 Restart confirmation packet

Figure 20 illustrates the format of the *restart confirmation* packet. Bits 4, 3, 2 and 1 of the first octet and all bits of the second octet are set to 0.

5 Procedures and formats for user facilities and network utilities

5.1 Description of optional user facilities

Signalling for CCITT specified DTE facilities and those user facilities (see Recommendation X.25) which do not require STE or transit network action is normally contained in the user facility field of X.75 packets. The contents of this field are conveyed transparently through an STE, which may examine and store them, but does not influence the progress of the call as a result.

Other user facilities which do require STE or transit network action are mapped into X.75 utilities and thus are not present in the X.75 facility field.

Octets	8	7	6	5	4	3	2	1
1	General format identifier (see Note)				0	0	0	0
2	0	0	0	0	0	0	0	0
3	Packet type identifier							
	1	1	1	1	1	1	1	1

NOTE – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 20/X.75

Restart confirmation packet format

5.2 Formats for optional user facilities

The formats for optional user facilities are described in Recommendation X.25.

5.3 Procedures for network utilities

The network utility field is a network administrative signalling mechanism in the *call request*, *call connected* and *clear request* packets. The network utility field complements the user facility field and serves to separate user service signalling from network administrative signalling. The request for a service through an optional user facility may, in certain instances, require the use of a network utility.

There are three categories of network utilities:

1) *International Mandatory network utilities* – These are the network utilities that must be supported by all international X.75 interworkings. International Mandatory means that every international STE must be capable of actioning the procedures for each network utility so classified. For some international mandatory utilities, not all calls need to signal the utility in the packet. International Mandatory utilities may also be used for national interworkings subject to bilateral agreements.

2) *International Optional network utilities* – These are the network utilities that may be supported by international X.75 interworkings, subject to bilateral agreements. When an international optional utility has been bilaterally agreed for use, the procedures herein described in this utility are used. International optional utilities may also be used for national interworkings subject to bilateral agreements.

3) *National network utilities* – These are the network utilities that may only be supported on links between networks in the same country, and are always subject to bilateral agreements.

The categorization of network utilities is given in Table 19. Utilities not listed in Table 19 are for further study and, therefore, no categorization is indicated.

TABLE 19/X.75

Categorization of network utilities

International mandatory network utilities	Clause
Transit network identification	5.3.1
Call identifier	5.3.2
Throughput class indication	5.3.3
Window size indication	5.3.5
Packet size indication	5.3.6
Fast select indication	5.3.7
Closed user group indication	5.3.8
Closed user group with outgoing access indication	5.3.9
Called line address modified notification	5.3.11
Transit delay indication	5.3.14
Call redirection or call deflection selection	5.3.18
Call redirection or call deflection notification	5.3.19
International optional network utilities	
Extended throughput class indication	5.3.4
Reverse charging indication	5.3.10
Clearing network identification code	5.3.12
Transit delay selection	5.3.15
Tariffs	5.3.16
Network user identification	5.3.17
Utility marker	5.3.21
National network utilities	
ROA selection	5.3.20

Several network utilities include the identification of a given network, If the given network is a public data network, it is identified by the first four digits (DNIC) of the international data number. However, if the given network is ISDN, it is identified by a four-digit field, the ISDN Network Identification Code (INIC), composed of:

0 + E.164 Country Code + National Network Digit(s)

where the number of National Network Digits depends on the size of E.164 Country Code, for a given country. National Network Digit(s) may be any value(s) agreed by the Administration within the given country. In order to identify additional ISDNs, some countries may also use the four-digit format composed of:

9 + E.164 Country Code + National Network Digit(s)

For national utilities, the possibility not to include the E.164 Country Code is for further study.

Alternate ways of ISDN network identification are for further study.

5.3.1 Transit network identification (International Mandatory)

The *transit network identification* is a network utility used to name a transit network controlling a portion of the (perhaps partially established) virtual circuit. A transit network is identified by its DNIC or INIC as specified in 5.3.

A *transit network identification* is always present in the *call request* packet for each transit network controlling the virtual circuit up to this point of call set-up. When more than one transit network is identified, the order of identification in the network utility field identical to the order of traversal of transit networks following the path being established from the calling DTE to the destination network.

A *transit network identification* is always present for each transit network in the *call connected* packet, or the *clear request* packet issued as a direct response to the *call request* packet. The *transit network identification* utility is not present in a *clear request* packet issued either after receipt of the corresponding *call connected* packet or after transmission of the corresponding *call request* or *call connected* packets. When there is more than one transit network, the identification order in the network utility field is identical to the order of transversal of transit networks following the path established from the calling to called DTE.

5.3.2 Call identifier (International Mandatory)

The *call identifier* is a network utility which is always present in the *call request* packet. The *call identifier* parameter is established by the originating network and is an identifying name for each virtual circuit established. The *call identifier* when used in conjunction with the calling DTE address, uniquely identifies the virtual call. The uniqueness is only guaranteed over a period of time. The duration of this time is for further study.

The use of the *call identifier* in the *call connected* packet is for further study. The *call identifier* is not present in the *clear request* packet.

NOTE – The definition of the content of the *call identifier*, and further specification of the associated signalling mechanisms, require further study. Pending such further study, the content of a *call identifier* may or may not be significant for a given call, this is under the responsibility of the originating network. However, it is for further study whether a transit network can create a significant *call identifier*, in the case it would receive a *call identifier* which is not significant. When the *call identifier* is not significant, it would be coded as zero by the originating network.

5.3.3 Throughput class indication (International Mandatory)

The *throughput class indication* is a network utility that can be used by any STE for specifying the throughput classes applying to that call.

The STE associated with the virtual call originating network may request in the *throughput class indication* utility of the *call request* packet the throughput class values selected at the calling DTE/DCE interface. Any transit STE may also request throughout class values in the *throughput class indication* utility of the *call request* packet. If particular throughput classes are not explicitly requested, the STE is assumed to request the default throughput class values agreed between both Administrations.

Any STE, including the STEs associated with the virtual call originating and destination network, may reduce but must not raise the throughput class values requested for the call. In reducing the throughput class values, different criteria can be envisaged by the STE. The STE should consider the packet sizes, the window sizes and the throughput classes that it can support at a given time. The STE may also consider the STE resources available and the throughput classes requested for that call. The STEs associated with the virtual call originating and destination networks may also consider the flow control parameters used at the DTE/DCE interface.

Taking the above considerations into account, the throughput class any STE reduces down to may vary per individual call and may be higher or lower than or equal to the default throughput class values agreed between both Administrations.

When the called DTE has accepted the call, the STE associated with the virtual call destination network may confirm in the *throughput class indication* utility of the *call connected* packet the throughput class values that finally apply to the virtual call following the negotiation with the called DTE. Any transit STE may also confirm throughput class values in the *throughput class indication* utility of the *call connected* packet. The STE should not alter the throughput class values received in a *call connected* packet.

If particular throughput classes are not explicitly confirmed, STE-Y is assumed to confirm the lesser of the default *throughput class* values agreed between both Administrations and the throughput class value requested originally. If an STE detects that an explicitly confirmed throughput class value finally applying to the call is higher than the one requested, it should clear the call with an indication of "Network congestion”.

The *throughput class indication* utility should not be present in the *clear request* packet. No indication of *throughput classes* should be present in the user facility field of the *call request*, *call connected* and *clear request* packets.

NOTE – Throughput class indication utility and extended throughput class indication utility should never be present in the same packet.

5.3.4 Extended throughput class indication (International Optional)

The extended throughput class indication is a network utility that can be used by the STE for specifying the throughput class applying to that call. Procedures applicable to extended throughput class indication are the same as those applicable to throughput class indication utility, as given in 5.3.3, except that the extended throughput class indication utility allows the STE to explicitly signal throughput class values higher than 256 kbit/s.

NOTE – *Throughput class indication* utility and *extended throughput class indication* utility should never be present in the same packet.

5.3.5 Window size indication (International Mandatory)

The *window size indication* is a network utility that can be used by any STE for negotiating the window sizes on a specified logical channel at the STE X/Y interface for each direction of transmission.

When using the *window size indication* utility in the *call request* packet, STE-X requests particular window sizes to be used at the STE X/Y interface for that call.

If particular window sizes are not explicitly requested, STE-X is assumed to request the default values for that call, that is either the standard value of 2 or other values agreed between both Administrations.

NOTE - For transmission over high speed channels with long round-trip delay, a larger window size than the standard value of 2 may be required. Appendix III provides guidelines.

When using the *window size indication* utility in the *call connected* packet, STE-Y confirms the window sizes finally applying at the STE X/Y interface to that call.

If particular window sizes are not explicitly confirmed, STE-Y is assumed to confirm the default values as finally applying to that call.

Each finally applying value should be in the range from the value requested by STE-X or assumed as a default value to the standard value of 2 (both inclusive). If an STE detects that a value finally applying to that call is out of this range, it should clear the call with an indication of “Network congestion”.

In altering the window size values, different criteria can be envisaged by the STE. The STE should consider the packet sizes, window sizes and the throughput classes that it can support at a given time. The STE may also consider the STE resources available and the throughput classes requested for that call. The STEs associated with the virtual call originating and destination networks may also consider the flow control parameters used at the DTE/DCE interface.

The *window size indication* utility should not be present in the *clear request* packet.

No indication of *window sizes* should be present in the user facility field of the *call request*, *call connected* and *clear request* packets.

5.3.6 Packet size indication (International Mandatory)

The *packet size indication* is a network utility that can be used by any STE for negotiating the maximum data field length of *data* packets on a specified logical channel at the STE X/Y interface for each direction of data transmission.

When using the *packet size indication* utility in the *call request* packet, STE-X requests the maximum data field lengths to be used at the STE X/Y interface for that call.

If particular data field lengths are not explicitly requested, STE-X is assumed to request default values for that call, that is either the standard value of 128 octets or other values agreed between both Administrations.

When using the *packet size indication* utility in the *call connected* packet, STE-Y confirms the data field lengths finally applying at the STE X/Y interface for that call.

If particular data field lengths are not explicitly confirmed, STE-Y is assumed to confirm the default values as finally applying to that call.

Each finally applying value should be in the range from the value requested by STE-X or assumed as a default value to the standard value of 128 octets (both inclusive). If an STE detects that a value finally applying to that call is out of this range, it should clear the call with an indication of "Network congestion".

In altering the data field length values, different criteria can be envisaged by the STE. The STE should consider the packet sizes, the window sizes and the throughput classes that it can support at a given time. The STE may also consider the STE resources available and the throughput classes requested for that call. The STEs associated with the virtual call originating and destination networks may also consider the flow control parameters used at the DTE/DCE interface.

The *packet size indication* utility should not be present in the *clear request* packet.

No indication of packet sizes should be present in the user facility field of the *call request*, *call connected* and *clear request* packets.

5.3.7 Fast select indication (International Mandatory)

The *fast select indication* is a network utility used for indicating that the *fast select* user facility applies to that call.

When using the *fast select indication* utility in the *call request* packet, the STE indicates that the *fast select* facility applies to that call, with the corresponding packet formats as described in 4.

When restriction on response is indicated in such a *call request* packet, the corresponding STE is permitted to issue as a direct response to this packet a *clear request* packet with a clear user data field of up to 128 octets, and is not authorized to send a *call connected* packet.

When no restriction on response is indicated in such a *call request* packet, the corresponding STE is permitted to issue as a direct response to this packet a *call connected* packet with a called user data field of up to 128 octets or at any time a *clear request* packet with a clear user data field of up to 128 octets. If the call is connected, the originating STE is authorized to transmit a *clear request* packet with a clear user data field of up to 128 octets.

No indication of *fast select* should be present in the user facility field of the *call request, call connected* and *clear request* packets.

The *fast select indication* utility should not be present in the *call connected* and *clear request* packets.

All other procedures of a call in which the *fast select* facility has been indicated are the same as those of a virtual call.

5.3.8 Closed user group indication (International Mandatory)

The *closed user group indication* is a network utility used for enabling the establishment of virtual calls by DTEs which are members of international closed user groups.

When using the *closed user group indication* utility in the *call request* packet, the STE indicates that the international virtual call is requested on the basis of valid international closed user group membership. The network of the calling DTE supplies the relevant international interlock code.

The STE should not alter the *closed user group indication* received in a *call request* packet.

Only one of the *closed user group indication* and the *closed user group with outgoing access indication* utilities may be present in a *call request* packet.

No indication of *closed user group* should be present in the user facility field of the *call request, call connected* and *clear request* packets.

The *closed user group indication* utility should not be present in the *call connected* and *clear request* packets.,

5.3.9 Closed user group with outgoing access indication (International Mandatory)

The *closed user group with outgoing access indication* is a network utility used for enabling the establishment of virtual calls by DTEs which are members of international closed user groups.

When using the *closed user group with outgoing access indication* utility in the *call request* packet, the STE indicates that the international virtual call is requested on the basis of valid international closed user group membership. In addition the STE signals an associated outgoing access capability. The network of the calling DTE supplies the relevant international interlock code.

The STE should not alter the *closed user group with outgoing access indication* received in a *call request* packet.

Only one of the *closed user group indication* and the *closed user group with outgoing access indication* utilities may be present in a *call request* packet.

No indication of *closed user group with outgoing access* should be present in the user facility field of the call *request call* connected and *clear reques*t packets.

The *closed user group with outgoing access* utility should not be present in the *call connected* and *clear request* packets.

5.3.10 Reverse charging indication (International Optional)

The *reverse charging indication* is a network utility used for enabling virtual calls to be established internationally, when the *reverse charging* facility applies.

When using the *reverse charging indication* utility in the *call request* packet, STE-X indicates a request for reverse charging to apply to the call.

In the absence of the *reverse charging indication* utility, STE-X is assumed not to request reverse charging for that call.

The *reverse charging indication* utility should not be present in the *call connected* and the *clear request* packets.

No indication of *reverse charging* should be present in the user facility field of the *call request, call connected* and *clear request* packets.

5.3.11 Called line address modified notification (International Mandatory)

The *called line address modified notification* is a network utility used for indicating the reasons for the called address in the packet being different from that specified in the initial *call request* packet.

The following reasons can be indicated with the use of the *called line address modified notification* utility:

i) call distribution within a hunt group;

ii) call redirection due to originally called DTE out of order,

iii) call redirection due to originally called DTE busy;

iv) call redirection due to prior request from the originally called DTE for systematic call redirection;

v) called DTE originated;

vi) call deflection by the originally called DTE.

Call distribution within a hunt group is limited to the network of the DTE originally called.

The *called line address modified notification* utility will be present in *call connected* packets where the called DTE address is different from that specified in the initial *call request* packets. It will also be present in the *clear request* packet where the call is cleared by a different DTE from the one originally called as a direct response to initial *call request* packet.

The *called line address modified notification* utility should not be present in the *call request* packet as well as the *clear request* packet sent after the call is connected.

No indication of *called line address modified notification* should be present in the user facility field of the *call request*, *call connected* and *clear reques*t packets.

5.3.12 Clearing network identification code (International Optional)

The *clearing network identification code* is a network utility providing additional information on the origin of the *clear request* packet and is present only in the *clear request* packet issued after the call is connected.

The network originating the *clear request* is identified by the DNIC or INIC of that network as specified in 5.3.

An STE receiving a *clearing network identification code* will pass this code unchanged whenever applicable.

5.3.13 Traffic class indication (for further study)

The traffic class utility indicates a service category for the virtual circuit being established. The *traffic class* signals service information (e.g., terminal, facsimile, maintenance) necessary for administering the call. Though their use is beyond the scope of this Recommendation, *traffic class* may have routing, tariff and other implications. The need for and definition of traffic classes are for further study.

5.3.14 Transit delay indication (International Mandatory)

The *transit delay indication* is a network utility that signals the accumulated expected nominal transit delay of a virtual circuit. It is included in the *call request* packet and *call connected* packet when a calling DTE has requested a transit delay in the *transit delay selection and indication* facility. The STE in the originating network will signal a value dependent on the characteristics of the originating network and on the characteristics of the outgoing link (e.g., link speed, satellite or cable).

Any outgoing STE in a transit network will add to the value received in the *transit delay indication* utility a value that depends on the characteristics of the network and the outgoing link.

The transit delay is defined as t_{3c} in Recommendation X.135, and is expressed in terms of a mean value. However, the detailed determination of the value is considered as a national matter. If the resulting value of the transit delay exceeds the maximum value that can be signalled in the utility parameter field, all bits of the utility parameter field will be set to “1”.

The STE will signal the final value of the accumulated expected nominal transit delay transparently in the *call connected* packet.

For an interim period, when not all networks have yet implemented the transit delay signalling, an STE will not send the *transit delay indication* utility to a network that does not support it. This STE will signal, towards its own network, all 1's in the *transit delay indication* utility parameter field of the *call connected* packet.

No indication of *transit delay selection and indication* should be present in the user facility field of the *call request, call connected* and *clear request packets*.

5.3.15 Transit delay selection (International Optional)

The *transit delay selection* utility is a network utility that signals the transit delay requested by the calling DTE in the *transit delay selection and indication* facility. This utility will be signalled transparently from the originating network to the destination network in the call request packet. This utility may be used in conjunction with the *transit delay indication* utility for routing purposes.

The *transit delay selection* utility should not be present in *call connected* or *clear request* packets.

No indication of *transit delay selection and indication* should be present in the user facility field of the *call request*, *call connected* and *clear request* packets.

5.3.16 Tariffs (International Optional)

The *tariffs* utility is a network utility that is used to pass information from one network to one or more other networks participating in the call for the purpose of implementing billing, accounting, or tariff arrangements that may exist among the respective Administrations.

The *tariffs* utility may appear in the *call request*, *call connected*, and *clear request* packets. If this utility appears in the *call request* packet, the information it contains relates to the originating interface or network. If this utility appears in the *call connected* or *clear request* packet, the information it contains relates to the ultimate destination interface or network. The utility may appear in a *clear request* packet only if that packet is initiated by the destination DTE or DCE, in direct response to the call request.

The content of this utility is determined by the originating or destination network and does not depend on information passed to the network by a DTE.

Even if this utility is supported on the STE X/Y interface, it may not be present in a packet for a given virtual call if there is no need to exchange tariff-related information with that packet.

No more than one instance of this utility may appear in a packet.

5.3.17 Network user identification (NUI) (International Optional)

The *network user identification* utility is a network utility used to provide supplementary network user identification for billing, security or network management purposes.

The utility may be present in the *call request* packet. No indication of *network user identification* should be present in the user facility field of any packet.

NOTE – Whether the utility may be present in the *call connected* packet is for further study.

This utility provides a mechanism for distinguishing a standardized CCITT default format from a format not constrained by this Recommendation.

A network may support some or all format options of this utility.

A network receiving this utility determines whether it is the network responsible for verifying the value. If it is not the network responsible for verifying the value, the network forwards the utility to the next network. It is for further study whether a network may forward this utility, over an international X.75 interface, to the next network if the NUI value has been verified. Forwarding of such utility with a verified NUI value over national X.75 interfaces is a national matter.

The originating network (STE), in formulating the value/content of this utility, may make use of DTE/DCE interface subscription options, network default assumptions, and/or values passed by the DTE on a per-call-basis.

5.3.18 Call redirection or call deflection selection (International Mandatory)

Call redirection or call deflection selection (CRCDS) is a network utility used for indicating to the originating network that the call is to be redirected or deflected and should be routed to the alternate destination whose address is contained within this utility. The reason for redirection or deflection is also provided. It is also used to pass utility information copied from the X.75 call request packet received by the network of the called DTE which requests inter-network call redirection/deflection (ICRD). This information, which is copied into the parameter field of this utility, can be used by the originating network to reconstruct a new call request packet to be sent to the alternate destination. When multiple redirections/deflections are allowed, the CRCDS utility is used by each network where the DTE requests ICRD in turn.

International Mandatory categorization of this utility is applicable only to transit networks. This means that a network should pass this utility unchanged when it appears in appropriate packets.

The network with the redirecting or deflecting DTE should copy into the CRCDS utility all of the following utilities that were received in the X.75 call request packet.

- Call identifier;
- Fast select indication;
- Reverse charging indication;
- Closed user group indication;
- Closed user group with outgoing access indication;
- Call redirection or deflection notification (see Note);
- Transit delay selection.

NOTE – The call redirection or deflection notification utility will only appear when the call has already undergone ICRD at least once. It will contain the address of the originally called DTE before any redirections or deflections as well as why the call was originally redirected or deflected.

The CRCDS utility may be present in a clear request packet when the originally called DTE has requested ICRD.

When the originating network receives a clear request packet containing this utility, it will determine whether a virtual call to the address specified in the utility may be set up. If one or more transit networks are required to complete the redirected or deflected call, the means used to select appropriate transit network(s) is a matter for the originating network. The ability to select appropriate transit networks for the redirected or deflected call attempt may be a factor in deciding whether the new virtual call may be set up. If the virtual call may not be set up, the originating network clears the call without attempting to reconstruct a new call request packet.

If the virtual call may be set up, the originating network should reconstruct a new call request packet using the address contained in the CRCDS utility as the called address. Inclusion rules and coding of utilities in the call request packet are detailed in Recommendation X. 301.

5.3.19 Call redirection or deflection notification (International Mandatory)

Call redirection or call deflection notification (CRCDN) is a network utility used to indicate that the call was not originally addressed to the DTE specified in the address field. It also indicates the reason for the original address change. That is, if multiple inter-network call redirection/deflections (ICRDs) are allowed, it will contain the address of the first DTE called and the reason for the first redirection or deflection.

International Mandatory categorization of this utility is applicable only to transit networks. This means that a network should pass this utility unchanged when it appears in appropriate packets.

The utility is present in a call request packet constructed by the originating network, after that network receives a clear request packet containing the CRCDS utility. If a copy of the CRCDN utility is not present in the parameter field of the CRCDS utility, the originating network copies the called address from the called address field of the clear request packet into the CRCDN utility. It also copies the reason for redirection or deflection from the CRCDS utility into the CRCDN utility.

If the copy of the CRCDN utility is present in the parameter field of the CRCDS utility, the call has already undergone ICRD. A network that does not support multiple ICRDs should clear the call with cause code "access barred" and diagnostic code #78. A network that does allow multiple ICRDs will include, in a newly constructed call request packet, the CRCDN utility as it appeared in the parameter field of the CRCDS.

The CRCDN utility should not be present in the call connected or clear request packets. In the clear request packet, the CRCDN utility may be present as part of the parameter field of CRCDS utility.

5.3.20 ROA selection (National)

ROA *selection* is a network utility that may be used to name a ROA transit network within the originating country through which a call is to be routed. In the case of international calls, this utility may indicate an international ROA in the originating country.

This utility can be used to carry a ROA transit network DNIC or INIC (see 5.3) specified by the calling DTE. When more than one transit network is specified by the calling DTE, a sequence of ROA *selection* utilities may be present in the *call request* packet. In this case, the order of identification of transit networks by the ROA *selection* utilities is identical to the order specified by the calling DTE.

A network receiving a *call reques*t packet containing one or more ROA *selection* utilities will route to the next requested network, removing the ROA *selection* utility that names the next requested network. If it is not possible to route to the next requested network, the receiving network will clear the call.

The ROA *selection* utility should not be present in the *call connected* and *clear request* packets. No indication of the ROA *selection* should be present in the user facility field of the *call request* packet.

5.3.2.1 Utility marker (International Optional)

The *utility marker* is used to separate international and national X.75 utilities, as defined under 5.3 from non-X.75 utilities that may be agreed bilaterally by the Administrations.

5.4 Formats for network utilities

5.4.1 General

The network utility field is present in all *call request* and *call connected* packets, and may be present in *clear request* packets, exchanged between STEs.

The utility field contains a number of utility elements. Each utility element consists of a utility code followed by a utility parameter.

If multiple instances of a utility parameter are required in the utility field, such as the ROA selection or *transit network identification,* this information will be presented in multiple utility elements with an identical utility code.

The utility codes are divided into four classes, by the use of bits 7 and 8, in order to specify utility parameters consisting of 1, 2, 3 or a variable number of octets. The general class coding is shown in Table 20.

TABLE 20/X.75

General class coding for network utility field

	Utility code field Bits 8	 7	 6	 5	 4	 3	 2	 1	
Class A	0	0	X	X	X	X	X	X	For single octet parameter field
Class B	0	1	X	X	X	X	X	X	For double octet parameter field
Class C	1	0	X	X	X	X	X	X	For triple octet parameter field
Class D	1	1	X	X	X	X	X	X	For variable length parameter field
NOTE – A bit which is indicated as X may be set to either 0 or 1 as discussed in the text.									

For class D, the octet following the utility code indicates the length, in octets, of the utility parameter. The utility parameter length is binary encoded and bit 1 is the low order bit.

The utility code field is binary coded and, without extension, provides for a maximum of 64 utility codes for classes A, B and C and 63 utility codes for class D giving a total of 255 utility codes (see Figure 21).

Utility code 1 1 1 1 1 1 1 1 is reserved for extension of the utility code. The octet following this octet indicates an extended utility code having the format A, B, C or D as defined in Figure 21. Repetition of utility code 1 1 1 1 1 1 1 1 is permitted and thus additional extensions result.

The specific coding of the utility parameter field is dependent on the utility being requested.

5.4.2 Coding of utility code field

The coding of the utility code field is given in Table 21.

Utility codings are the same for *call request, call connected* and *clear request* packets.

5.4.3 Coding of utility parameter field

5.4.3.1 Coding of transit network identification utility parameter

Each of the four digits is coded in a semi-octet in binary coded decimal with bit 5 or 1 being the low order bit of the digit. The high order digit is coded into bits 8 to 5 of the first octet of the parameter.

5.4.3.2 Coding of the call identifier utility parameter

The call identifier consists of 24 bits of binary data.

5.4.3.3 Coding of throughput class indication utility parameter

The throughput class for transmission from the calling STE is indicated in bits 4, 3, 2 and 1. The throughput class for transmission from the called STE is indicated in bits 8, 7, 6 and 5.

The four bits indicating each throughput class are binary coded and correspond to throughput classes as indicated in Table 22.

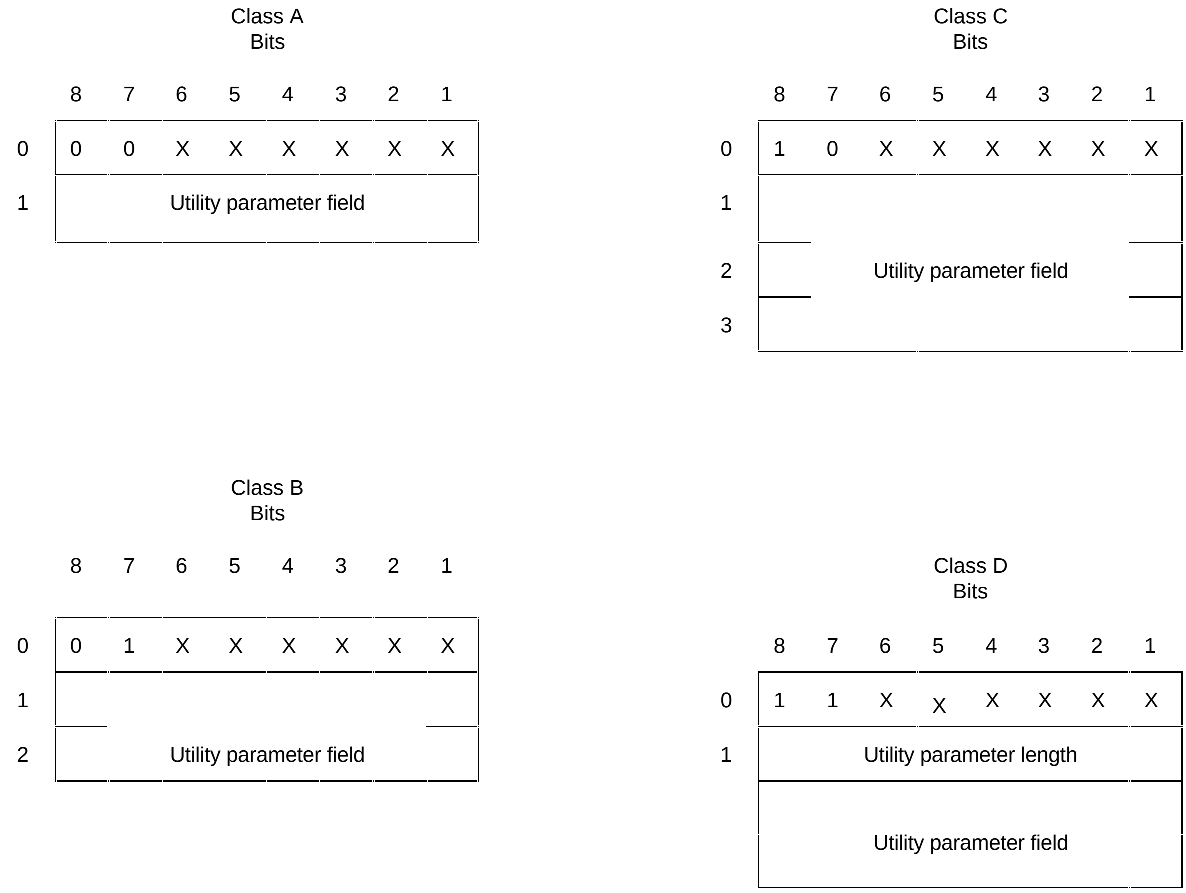


FIGURE 21/X.75

Utility code general formats

5.4.3.4 Coding of extended throughput class indication utility

The throughput class for transmission from the calling STE is indicated in bits 5 to 1 of the first octet of the utility parameter field. The throughput class for transmission from the called STE is indicated in bits 5 to 1 of the second octet. Bits 8, 7 and 6 of each octet must be zero and are reserved for future allocation.

The bits indicating each throughput class are binary coded and correspond to throughput classes as indicated in Table 23.

5.4.3.5 Coding of window size indication utility parameter

The window size for the direction of transmission from the called STE is indicated in bits 7 to 1 of the first octet. The window size for the direction of transmission from the calling STE is indicated in bits 7 to 1 of the second octet. Bit 1 is the least significant bit. Bit 8 of each octet is unassigned and set to 0. Each window size value is binary encoded.

The range of window size values allowed at the STE X/Y interface is subject to a bilateral agreement between Administrations. Window sizes of 8 to 127 are only valid for calls which employ extended numbering.

TABLE 21/X.75

Coding of the utility code field

Utility	Packet types in which it may be used			Utility code Bits							
	Call request	Call connected	Call request	8	7	6	5	4	3	2	1
Transit network identification	X	X	X (Note 1)	0	1	0	0	0	0	0	1
Call identifier	X	(Note 2)		1	0	0	0	0	0	0	1
Throughput class indication	X	X		0	0	0	0	0	0	1	0
Extended throughput class indication	X	X		0	1	0	0	1	1	0	0
Window size indication	X	X		0	1	0	0	0	0	1	1
Packet size indication	X	X		0	1	0	0	0	0	1	0
Fast select and/or reverse charging indication	X			0	0	0	0	0	0	0	1
Closed user group indication	X			1	1	0	0	0	0	1	1
Closed user group with outgoing access indication	X			1	1	0	0	0	1	1	1
Called line address modified notification		X	X (Note 1)	0	0	0	0	1	0	0	0
Call redirection or call deflection selection			X (Note 1)	1	1	0	1	0	0	0	1
Call redirection or call deflection notification	X			1	1	0	1	0	1	0	0
Clearing network identification code			X (Note 3)	0	1	0	0	1	0	1	0
Traffic class indication	(Note 4)			0	0	0	0	0	0	1	1
Transit delay indication	X	X		0	1	0	0	1	0	0	1
Transit delay selection	X			0	1	0	0	1	0	1	1
Tariffs	X	X	X (Note 1)	0	0	0	0	0	1	1	1
NUI	X	(Note 2)		1	1	0	0	0	1	1	0
ROA selection	X			0	1	0	0	0	1	0	0
Utility marker	X	X	X	0	0	0	0	0	0	0	0

NOTES

1 It is present in the *clear request* packet issued as a direct response to the *call request* packet.

2 The use of the *utility* in the *call connected* packet is for further study.

3 It is present only in the *clear request* packet issued after the call is connected.

4 The procedure is for further study.

TABLE 22/X.75

Coding of throughput classes for throughput class indication utility

Bit: or Bit:	4 / 8	3 / 7	2 / 6	1 / 5	Throughput class (bit/s)
	0	0	0	0	Reserved
	0	0	0	1	Reserved
	0	0	1	0	Reserved
	0	0	1	1	75
	0	1	0	0	150
	0	1	0	1	300
	0	1	1	0	600
	0	1	1	1	1200
	1	0	0	0	2400
	1	0	0	1	4800
	1	0	1	0	9600
	1	0	1	1	19 200
	1	1	0	0	48 000
	1	1	0	1	64 000
	1	1	1	0	128 000
	1	1	1	1	192 000 or higher

5.4.3.6 Coding of packet size indication utility parameter

The maximum user data field length for the direction of transmission from the called STE is indicated in bits 4 to 1 of the first octet. The maximum user data field length for the direction of transmission from the calling STE is indicated in bits 4 to 1 of the second octet. Bits 8 to 5 of both octets are unassigned and set to 0.

The four bits indicating each maximum user data field length are binary encoded and express the logarithm to base 2 of the maximum number of octets of the data field of data packets. Bit. 1 is the least significant bit.

The maximum user data field length values allowed at the STE X/Y interface are subject to a bilateral agreement between Administrations; however all Administrations will allow 128 octets.

5.4.3.7 Coding of fast select and/or reverse charging indication utility parameter

Bit:	8	7	6	5	4	3	2	1
Code:	X	Y	U	U	U	U	U	Z

U = Unassigned and set to 0;

X = 0 and Y = 0 or 1 for *fast select* not requested;

X = 1 and Y = 0 for *fast select* requested with no restriction on response;

X = 1 and Y = 1 for *fast select* requested with restriction on response;

Z = 0 for *reverse charging* not requested; and

Z = 1 for *reverse charging* requested.

TABLE 23/X.75

Coding of throughput classes for extended throughput class indication utility

Bits	8	7	6	5	4	3	2	1	Throughput class (bit/s)
	0	0	0	0	0	0	0	0	Reserved
	0	0	0	0	0	0	0	1	Reserved
	0	0	0	0	0	0	1	0	Reserved
	0	0	0	0	0	0	1	1	75
	0	0	0	0	0	1	0	0	150
	0	0	0	0	0	1	0	1	300
	0	0	0	0	0	1	1	0	600
	0	0	0	0	0	1	1	1	1200
	0	0	0	0	1	0	0	0	2400
	0	0	0	0	1	0	0	1	4800
	0	0	0	0	1	0	1	0	9600
	0	0	0	0	1	0	1	1	19 200
	0	0	0	0	1	1	0	0	48 000
	0	0	0	0	1	1	0	1	64 000
	0	0	0	0	1	1	1	0	128 000
	0	0	0	0	1	1	1	1	192 000
	0	0	0	1	0	0	0	0	256 000
	0	0	0	1	0	0	0	1	320 000
	0	0	0	1	0	0	1	0	384 000
	0	0	0	1	0	0	1	1	448 000
	0	0	0	1	0	1	0	0	512 000
	0	0	0	1	0	1	0	1	576 000
	0	0	0	1	0	1	1	0	640 000
	0	0	0	1	0	1	1	1	704 000
	0	0	0	1	1	0	0	0	768 000
	0	0	0	1	1	0	0	1	832 000
	0	0	0	1	1	0	1	0	896 000
	0	0	0	1	1	0	1	1	960 000
	0	0	0	1	1	1	0	0	1 024 000
	0	0	0	1	1	1	0	1	1 088 000
	0	0	0	1	1	1	1	0	1 152 000
	0	0	0	1	1	1	1	1	1 216 000
	0	0	1	0	0	0	0	0	1 280 000
	0	0	1	0	0	0	0	1	1 344 000
	0	0	1	0	0	0	1	0	1 408 000
	0	0	1	0	0	0	1	1	1 472 000
	0	0	1	0	0	1	0	0	1 536 000
	0	0	1	0	0	1	0	1	1 600 000
	0	0	1	0	0	1	1	0	1 664 000
	0	0	1	0	0	1	1	1	1 728 000
	0	0	1	0	1	0	0	0	1 792 000
	0	0	1	0	1	0	0	1	1 856 000
	0	0	1	0	1	0	1	0	1 920 000
	0	0	1	0	1	0	1	1	1 984 000
	0	0	1	0	1	1	0	0	2 048 000
Other values									Reserved

5.4.3.8 Coding of closed user group code and closed user group code with outgoing access

5.4.3.8.1 Utility parameter length

Bit:	8	7	6	5	4	3	2	1
Code:	0	0	0	0	0	1	0	0

5.4.3.8.2 Utility parameter

The international interlock code is contained in the utility parameter field and consists of four octets.

The first two octets of the international interlock code consist of the four digits of DNIC or INIC as specified in 5.3. Each digit is coded in a semi-octet in binary coded decimal with bit 5 or 1 being the low order bit of the digit. The high order digit is coded into bits 8 to 5 of the first octet of the parameter.

The remaining two octets contain the remaining 16 bits of the international interlock code, encoded with bit 8 of the third parameter octet as the high order bit.

5.4.3.9 Coding of called line address modified notification utility parameter

Bits:	8	7	6	5	4	3	2	1	
	0	0	0	0	0	1	1	1	Call distribution within a hunt group;
	0	0	0	0	0	0	0	1	Call redirection due to originally called DTE; busy;
	0	0	0	0	1	0	0	1	Call redirection due to originally called DTE out of order;
	0	0	0	0	1	1	1	1	Call redirection due to prior request from originally called DTE for systematic call redirection;
	1	0	X	X	X	X	X	X	Called DTE originated (see Note 1);
	1	1	X	X	X	X	X	X	Called deflection by the originally called DTE (see Note 2).

NOTES

1 Each X may be independently set to 0 or 1 by the called DTE and is passed transparently.

2 The Xs are those set by the originally called DTE in the call forwarding selection facility.

5.4.3.10 Coding of clearing network identification code parameter

Each of the four digits of the DNIC or INIC of the clearing network are contained in the utility parameter field which consists of two octets. Each digit is coded in a semi-octet in binary coded decimal with bit 5 or 1 being the low order bit of the digit. The high order digit is coded into bits 8 to 5 of the first octet of the parameter.

5.4.3.11 Coding of traffic class indication utility parameter

The coding of the traffic class parameter is for further study.

5.4.3.12 Coding of transit delay indication utility parameter

This parameter is two octets. Transit delay is expressed in milliseconds, binary coded, with bit 8 of octet 1 being the high order bit and bit 1 of octet 2 being the low order bit.

5.4.3.13 Coding of the transit delay selection utility parameter

This parameter is two octets. Transit delay is expressed in milliseconds, binary coded, with bit 8 of octet 1 being the high order bit and bit 1 of octet 2 being the low order bit.

5.4.3.14 Coding of the tariffs utility parameter

The one octet parameter field consists of two subfields of 5 bits and 3 bits respectively:

Bit:	8	7	6	5	4	3	2	1
Code:	P	P	P	P	P	U	U	U

The interpretation of the first subfield which is called Primary tariff subfield is specified by Tables 24 and 25.

TABLE 24/X.75

Coding of primary tariff subfield

PPPPP 87654	Primary tariff subfield
00000 00001	Subclass code 0 Subclass code 1
. . .	. . .
11110 11111	Subclass code 30 Subclass code 31

TABLE 25/X.75

Interpretation of primary subclass codes

Primary subclass code(S)	Interface
0	X.25
1	Switched access X.28
2	Dedicated access X.28
3	X.32
4	X.75
5-15	[Reserved] (Note)
16-30	Reserved for national use
31	Unspecified or non-standard
NOTE – It is for further study whether a portion of the reserved range will be used to specify access interfaces associated with ISDN service.	

The three bits of the second subfield (UUU) are used to designate a secondary, network-specific subclass code that has billing, accounting, or tariff significance. The origination/destination network can optionally use this subfield to specify one of up to seven subclass codes, with a significance set by the network providing the tariff class code value. If this secondary subfield is not utilised, it should be zero filled.

5.4.3.15 Coding of network user identification utility parameter

The octet following the utility code field indicates the length, in octets, of the utility parameter field. The next octet (the first octet of the parameter field) has one of two alternative formats:

a) *CCITT Standardized Default Format*:

Bit:	8	7	6	5	4	3	2	1
	1	1	V	R	N	F	V	E

Where V, R, NF, VE, and the remaining octets of parameter field for this case are specified below.

b) *Format Not Constrained by This Recommendation:*

Bit:	8	7	6	5	4	3	2	1
	Y	Y	X	X	X	X	X	X

Where YY = 00, 01, or 10. Neither XXXXXX nor the remaining octets of the parameter field in this case are constrained by this Recommendation.

For the CCITT standardized default format [case a) above], all of the following apply:

V Bit: 6

0 NUI Value Unverified

1 (Reserved for "NUI Value Verified")

The use and coding of the R bit is for further study. Until this use is specified, this bit value, is always to be set to 0.

The format option used for the NUI code proper is encoded in the NF bits:

NF Bits: 4 3

0 0 First Subfield Conforms to ISO 7812/CCITT E.118

0 1 No Constraints on Following Octets

1 0 Subfield Format: No Content Constraints

1 1 [*Reserved*]

The verifying entity is encoded in the VE bits:

VE Bits: 2 1

0 0 Originating Network

0 1 Destination Network

1 0 First Transit Network (Note)

1 1 Other/Not Specified

NOTE – The use of international transit networks as verifying entities is for further study.

If NF = 01, the remaining octets of the parameter field are not constrained by this Recommendation. If NF = 00 or NF = 10, the remaining octets of the parameter field contain the NUI code proper and are divided into *m* subfields (*m* greater or equal to 1) and each subfield is defined as follows:

	Bits 8	7	6	5	4	3	2	1
I	Type				0	0	0	0
I + 1	Subfield length							
I + 2								
	. . .			Subfield information				. . .
I + J								

where I is the number of the initial octet of the subfield and (J-1) is the number of octets of information in the subfield. The type semi-octet specifies the encoding format for the information of the subfield, as follows:

Bits 8	7	6	5	
1	1	0	1	BCD semi-octet
1	1	0	0	IA5 (T.50) with bit 8 = 0
1	1	1	0	Reserved for national use
1	1	1	1	
Other				For future definition

Bits 4 through 1 of the first octet of each subfield are set to 0. Other values for this semi-octet are reserved for future use.

Subfield length is the number of semi-octets of information in the subfield, and is encoded in binary.

NOTES

1 For Type = 1100 (IA5), subfield length must be an even value. For Type = 1101 (BCD), subfield length may be an even or odd value, although an integral number of octets will be assured by inserting zeros in bits 4, 3, 2 and 1 of the last octet of the subfield when necessary.

2 The need for a maximum value for the length of this utility parameter field, and the value of such a maximum, are for further study.

5.4.3.16 Coding of call direction or call deflection selection utility

The octet following the utility code field indicates the length in octets, coded in binary, of the utility parameter field and has a value $n + m + 2$, where n is the number of octets necessary to hold the address of the alternate DTE and where m is the number of octets necessary to encode the additional utility and facility information carried in the parameter field.

The first octet of the utility parameter field indicates the reason for redirection or deflection and has one of the following values:

Bit:	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	0	1	Call redirection due to originally called DTE, busy
	0	0	0	0	1	0	0	1	Call redirection due to originally called DTE out of order
	0	0	0	0	1	1	1	1	Call redirection due to prior request from originally called DTE for systematic call redirection
	1	1	X	X	X	X	X	X	Called deflection by the originally called DTE (see Note)

NOTE – The Xs are those set by the called DTE in the X.25 call deflection selection facility.

The second octet indicates the number of semi-octets in the called DTE address. This address length indicator is binary encoded and bit 1 is the low order bit. Its value is limited to a maximum of 15.

The next *n* octets, up to a maximum of 8, contain the address of the alternate DTE coded identically to that of the called DTE address field in call request packets. When the total number of digits in the called and calling DTE address filed is odd, a semi-octet with zeros in bits 4, 3, 2 and 1 will be inserted after the calling DTE address field in order to maintain octet alignment.

NOTE – It is for further study whether the current limit of 15 on the value of the address length indicator will be relaxed- and the address coding modified to bring: this encoding into alignment with “A bit” and “TOA/NPI” address coding format option of Recommendation X.25.

The remaining octets of the parameter field contain all of the following utilities that were received in the X.75 call request packet:

– Call identifier;

– Fast select indication;

– Reverse charging indication;

– Closed user group indication;

– Closed user group with outgoing access indication;

– Call redirection or deflection notification;

– Transit delay selection.

5.4.3.17 Coding of call redirection or deflection notification

The octet following the utility code field indicates the length in octets of the utility parameter field and has the value *n*+ 2, where *n* is the number of octets necessary to hold the address of the originally called DTE. The first octet of the utility parameter field indicates the reason for redirection or deflection and has the following values:

Bit:	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	0	1	Call redirection due to originally called DTE, busy
	0	0	0	0	1	0	0	1	Call redirection due to originally called DTE out of order
	0	0	0	0	1	1	1	1	Call redirection due to prior request from originally called DTE for systematic call redirection
	1	0	X	X	X	X	X	X	Calling DTE originated (see Note 1)
	1	1	X	X	X	X	X	X	Called deflection by the originally called DTE (see Note 2)

NOTES

1 When more than one address applies to a DTE/DCE interface, the call redirection or call deflection notification facility may be used by the DTE in an X.25 call request packet to inform the called DTE that the call has been redirected or defected in the calling DTE (which is supposed to be a packet switched private data network). The Xs are those set by the calling DTE.

2 The Xs are those set by the called DTE in the X.25 call deflection selection facility.

The second octet indicates the number of semi-octets in the originally called DTE address. This address length indicator is binary encoded and bit 1 is the low order bit. Its value is limited to a maximum of 15.

The next *n* octets, up to a maximum of 8, contain the address of the originally called DTE coded identically to that of the called DTE address field in call request packets.

NOTE – It is for further study whether the current limit of 15 on the value of the address length indicator will be relaxed and the address coding modified to bring this encoding into alignment with "A bit" and "TOA/NPI" address coding format option of Recommendation X.25.

5.4.3.18 Coding of ROA selection utility

The parameter field contains the DNIC or INIC (see 5.3) for a requested ROA transit network and is in the form of four decimal digits.

Each digit is coded in a semi-octet in binary coded decimal with bit 5 or 1 being the low order bit of the digit. The high order digit is coded into bits 8 to 5 of the first octet of the parameter.

5.4.3.19 Coding of the utility marker utility parameter

Bit:	8	7	6	5	4	3	2	1
Code:	0	0	0	0	0	0	0	0

Annex A

Definition of symbols for Annexes B, C and D

(This annex forms an integral part of this Recommendation)

A.1 General

This annex contains the definitions for the symbols to be used in Annexes B, C and D. Annex B defines the states of the X/Y interface and the transitions between states in the normal case, while Annex C contains the full definition of actions, if any, to be taken on the receipt of packets by an STE. Annex D describes the actions taken by the STE on time-outs, if any, in the packet layer.

A.2 Symbol definition of the state diagrams

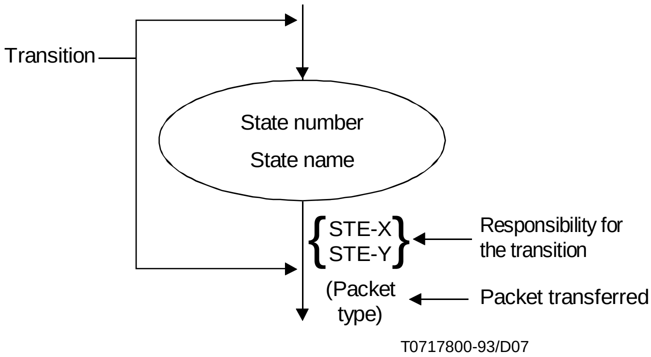
See Figure A.1.

A.3 Order definition of the state diagrams

For the sake of clarity, the normal procedure at the interface is described in a number of small state diagrams. In order to describe the normal procedure fully, it is necessary to allocate a priority to the different figures and to relate a higher order diagram with a lower one. This has been done by the following means:

– The figures are arranged in order of priority with Figure A.2 (*restart*) having the highest priority and subsequent figures having lower priority. Priority means that when a packet belonging to a higher order diagram is transferred, that diagram is applicable and the lower order one is not.

– The relation with a state in a lower order diagram is given by including that state inside an ellipse in the higher order diagram.



NOTES

1 Each state is represented by an ellipse wherein the state name and number are indicated.

2 Each state transition is represented by an arrow. The responsibility for the transition (STE-X or STE-Y) and the packet that has been transferred are indicated beside that arrow.

FIGURE A.1/X.75

Symbol definition of the state diagrams

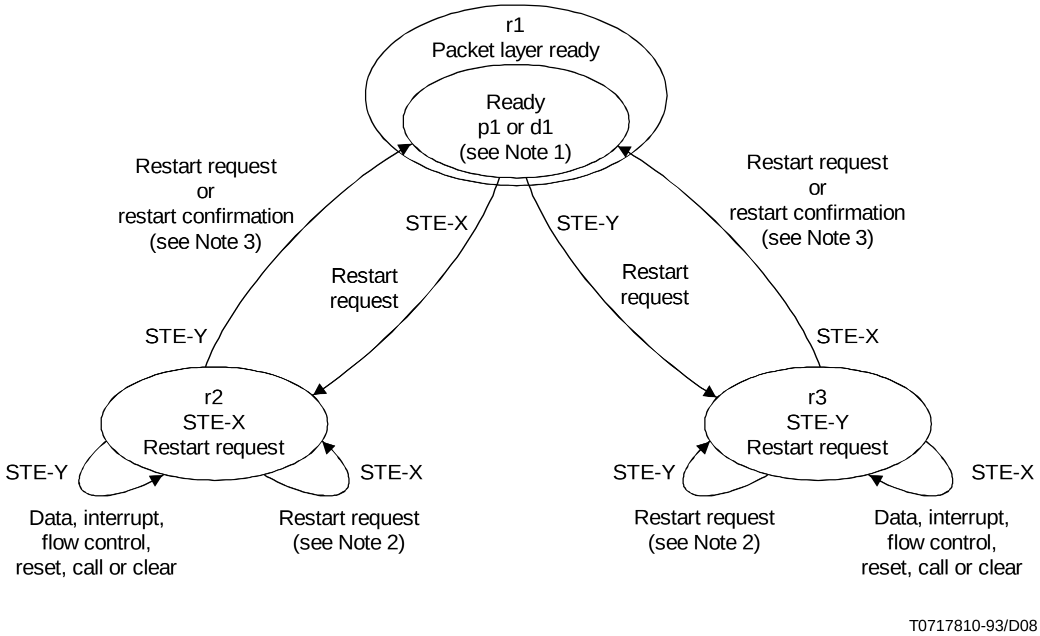
A.4 Symbol definition of the action tables

The entries given in Tables C.1 to C.5 and D.1 (see Annexes C and D) indicate the action, if any, to be taken by an STE on receipt of any kind of packet, and the state the STE enters, which is given in parenthesis, following the action taken.

Annex B

State diagrams for the packet layer interface between STEs for normal cases

(This annex forms an integral part of this Recommendation)



NOTES

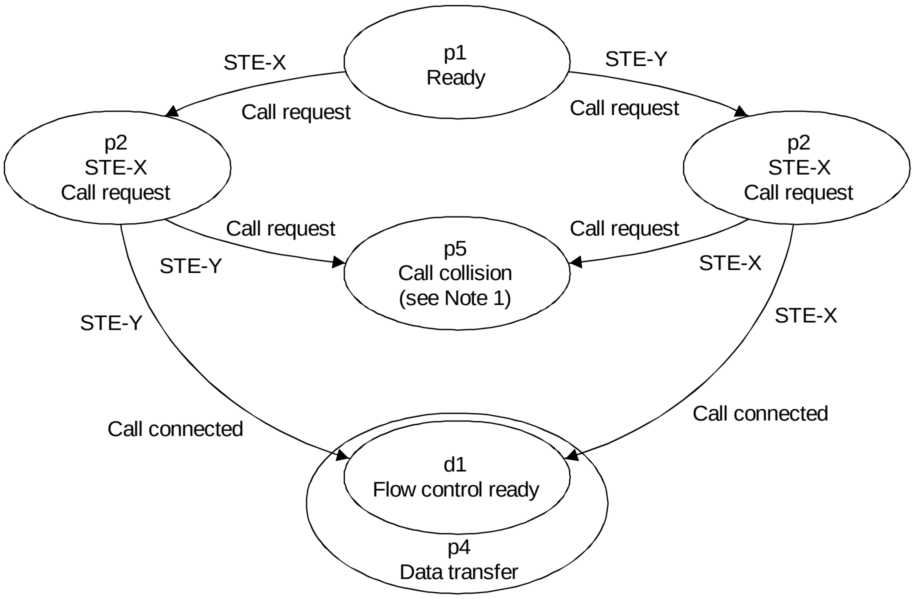
1 State p1 for virtual calls or state d1 for permanent virtual circuits.

2 This transition takes place after time-out T30 expires the first time.

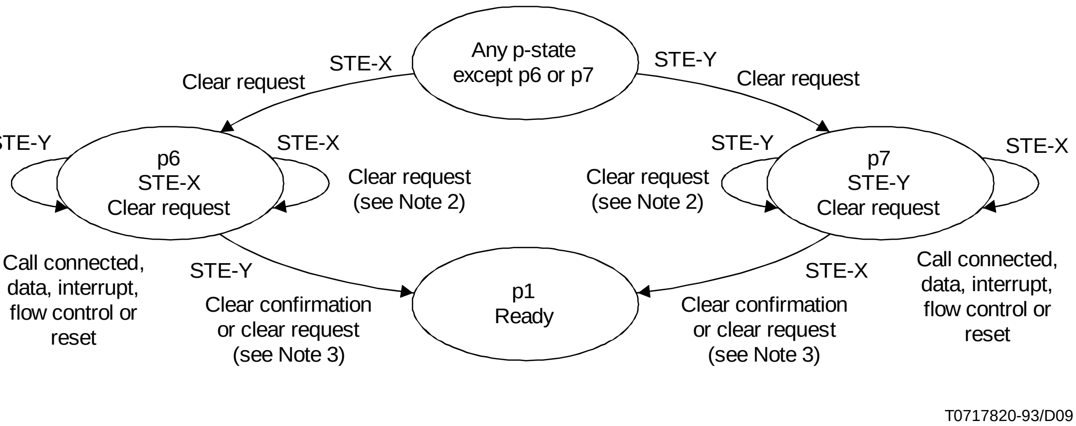
3 This transition takes place without the transmission of the packet after time-out T30 expires the second time.

FIGURE B.1/X.75

Diagram of states for the transfer of restart packets



a) Transfer of call establishment packets



b) Transfer of call clearing packets

NOTES

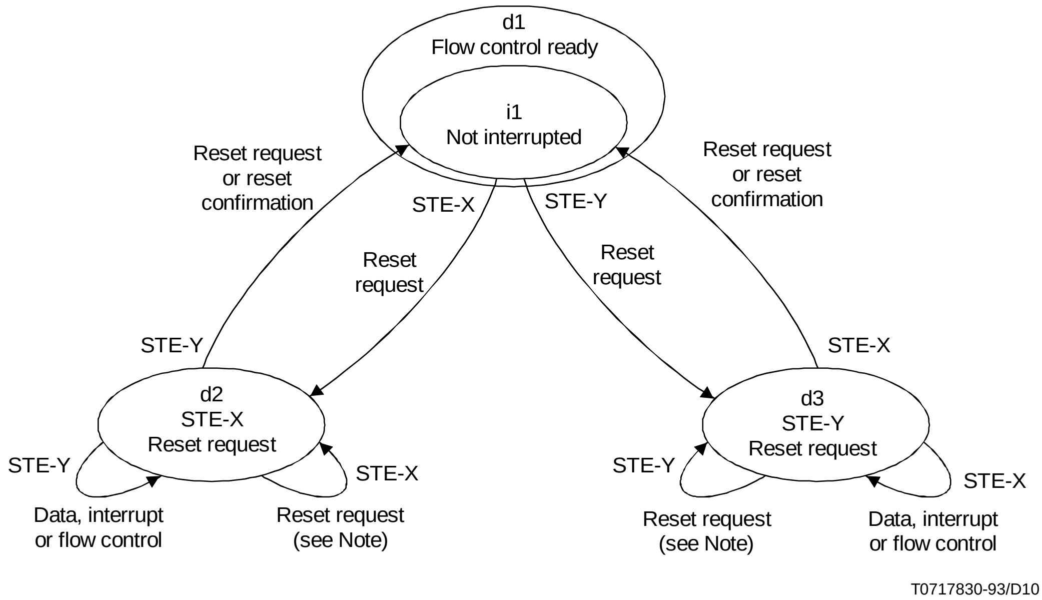
1 STE-X/Y shall issue a *clear request* packet and proceed to states p6/p7.

2 This transition takes place after time-out T33 expires the first time.

3 This transition takes place without the transmission of the packet after time-out T33 expires the second time.

FIGURE B.2/X.75

State diagrams for the transfer of call establishment and call clearing packets within the packet layer ready (r1) state on a logical channel



NOTE – This transition may take place after time-out T32 expires the first time.

FIGURE B.3/X.75

Diagram of states for the transfer of reset packets within the data transfer (p4) state on a logical channel

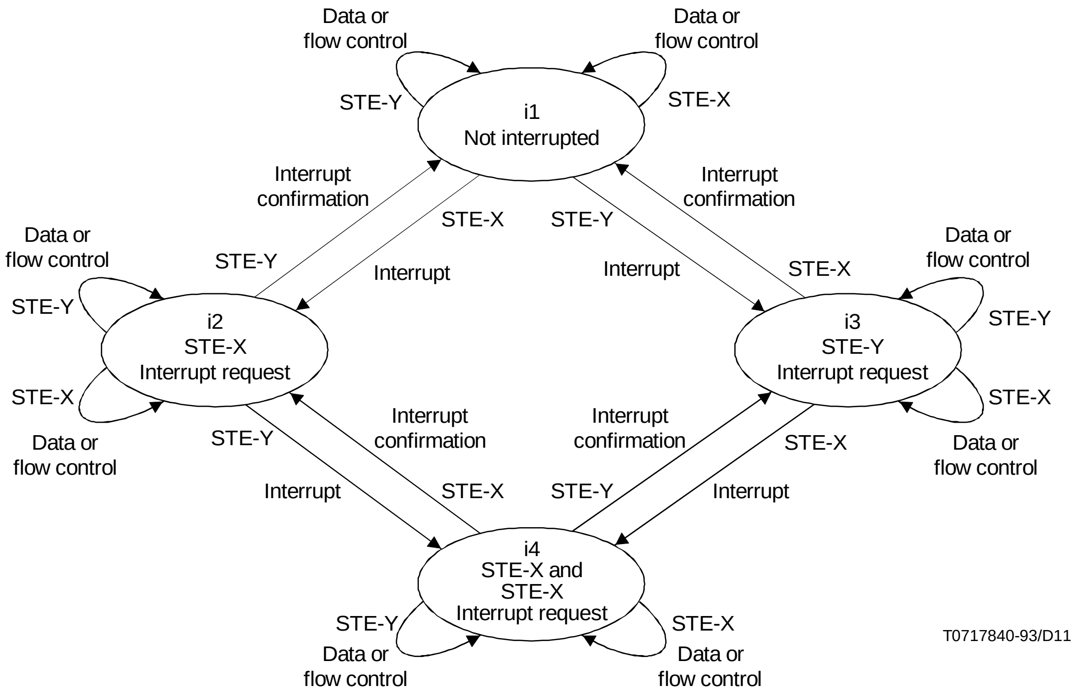


FIGURE B.4/X.75

Diagram of states for the transfer of data, flow control and interrupt packets within the flow control ready (d1) state on a logical channel

Annex C

Actions taken by the STE on receipt of packets in a given state of the packet layer X/Y interface

(This annex forms an integral part of this Recommendation)

NOTE – Actions are specified for STE-Y only. STE-X should follow the same procedure.

TABLE C.l/X.75

Action taken by STE-Y on receipt of packets

Packet received by STE-Y	State of the interface as perceived by STE-Y
	Any state
Any packet with unassigned logical channel (see Note)	DISCARD
Any packet with less than 2 octets	
Any packet with an incorrect general format identifier	
Any packet with correct general format identifier and assigned logical channel (see Note)	(See Table C.2)

DISCARD STE-Y discards the received packet and takes no subsequent action.

NOTE – Assigned logical channel includes the case where bits 1 to 4 of octet 1 and bits 1 to 8 of octet 2 are all 0s.

TABLE C.2/X.75

Action taken by STE-Y on receipt of packets In a given state: restart

<table>
<tr><th rowspan="2">Packet received by STE-Y</th><th colspan="3">State of the interface as perceived by STE-Y</th></tr>
<tr><th>Packet layer
ready
r1</th><th>STE-X restart
request
r2</th><th>STE-Y restart
request
r3</th></tr>
<tr><td>Restart request</td><td>NORMAL (r2)</td><td>DISCARD (r2)</td><td>NORMAL (r1)</td></tr>
<tr><td>Restart confirmation</td><td>ERROR (r3)
17</td><td>ERROR (r3)
(see Note 1)
18</td><td>NORMAL
(r1)</td></tr>
<tr><td>Restart request or confirmation with bit 1 to 4 of octet 1 or bit 1 to 8 of octet 2 ≠ 0</td><td rowspan="3">(See Table C.3)</td><td>ERROR (r3)
(see Note 1)
41</td><td rowspan="3">DISCARD
(r3)</td></tr>
<tr><td>Data, interrupt, flow control, reset call set-up or clear when both logical channel number and logical channel group number are not all 0s</td><td>ERROR (r3)
(see Note 1)
18</td></tr>
<tr><td>Packet having a packet type identifier which is shorter than 1 octet or is incompatible with the ones defined in clause 4 when both logical channel number and logical channel group number are not all 0s</td><td>ERROR (r3)
(see Note 1)
38 or # 33</td></tr>
<tr><td>Data, interrupt, flow control, reset call set up, clear, packet having a packet type identifier which is shorter than 1 octet or is incompatible with the ones defined in clause 4 when both logical channel number and logical channel group number are all 0s</td><td>DISCARD
(r1)</td><td>DISCARD
(r2)</td><td>DISCARD
(r3)</td></tr>
</table>

NORMAL The action taken by STE-Y follows the normal procedures as defined in clause 3 (see Note 2).

DISCARD STE-Y discards the received packet and takes no subsequent action.

ERROR STE-Y discards the received packet and indicates restarting with “network congestion” cause and decimal diagnostic value # n.

NOTES

1 If STE-Y issues a *restart request* packet as a result of an error condition in state r2, it should follow the actions described in Annex D.

2 In the two following error situations the STE will invoke the ERROR (r3) procedure:

a) a *restart request* packet or *restart confirmation* packet received in state r3 exceeds the maximum permitted length, is too short or (where detection of non-octet alignment is made at packet layer) is not octet aligned; diagnostic values # 39, # 38 and # 82 respectively are used.

b) a *restart request* packet received in state rl exceeds the maximum permitted length, is too short or (where detection of non-octet alignment is made at packet layer) is not octet aligned; diagnostic values # 39, # 38 and # 82 respectively, are used.

TABLE C.3/X.75

Action taken by STE-Y on receipt of packets specifying an assigned logical channel in a given state: call establishment and clearing

<table>
<tr><th rowspan="3">Packet received by STE-Y</th><th colspan="6">State of the interface as perceived by STE-Y</th></tr>
<tr><th colspan="6">Packet layer ready rl</th></tr>
<tr><th>Ready
p1</th><th>STE-X call request
p2</th><th>STE-X call request
p3</th><th>Data transfer
p4</th><th>STE-X clear request
p6</th><th>STE-Y clear request
p7</th></tr>
<tr><td>Call request</td><td>NORMAL
(p2)</td><td>ERROR
(p7)
21</td><td>ERROR
(p7)
116</td><td>ERROR
(p7)
23</td><td>ERROR
(p7)
(see Note 1)
25</td><td>ERROR
(p7)
26</td></tr>
<tr><td>Call connected</td><td>ERROR
(p7)
20</td><td>ERROR
(p7)
21</td><td>NORMAL
(p4)
(see Note 2)</td><td>ERROR
(p7)
23</td><td>ERROR
(p7)
(see Note 1)
25</td><td>DISCARD
(p7)</td></tr>
<tr><td>Clear request</td><td>NORMAL
(p6)</td><td>NORMAL
(p6)</td><td>NORMAL
(p6)</td><td>NORMAL
(p6)</td><td>DISCARD
(p6)</td><td>NORMAL
(p1)</td></tr>
<tr><td>Clear confirmation</td><td>DISCARD
(p1)</td><td>ERROR
(p7)
21</td><td>ERROR
(p7)
22</td><td>ERROR
(p7)
23</td><td>ERROR
(p7)
(see Note 1)
25</td><td>NORMAL
(p1)</td></tr>
<tr><td>Data, interrupt, flow control or reset</td><td>ERROR
(p7)
20</td><td>ERROR
(p7)
21</td><td>ERROR
(p7)
22</td><td rowspan="3">(see
Table C.4)</td><td>ERROR
(p7)
(see Note 1)
25</td><td rowspan="3">DISCARD
(p7)</td></tr>
<tr><td>Restart request or confirmation with bit 1 to 4 of octet 1 or bit 1 to 8 of octet 2 ≠ 0</td><td>ERROR
(p7)
41</td><td>ERROR
(p7)
41</td><td>ERROR
(p7)
41</td><td>ERROR
(p7)
(see Note 1)
41</td></tr>
<tr><td>Packet having a packet type identifier which is shorter than 1 octet or is incompatible with the ones defined in clause 4</td><td>ERROR
(p7)
38 or # 33</td><td>ERROR
(p7)
38 or # 33</td><td>ERROR
(p7)
38 or # 33</td><td>ERROR
(p7)
(see Note 1)
38 or # 33</td></tr>
</table>

NORMAL The action taken by STE-Y follows the normal procedures as deemed in clause 3. However, if an error condition specified in Annex F occurs, STE-Y discards the received packet and indicates clearing with the cause and diagnostic codes specified in Annex F.

DISCARD STE-Y discards the received packet and takes no subsequent action.

ERROR STE-Y discards the received packet and indicates clearing with “network congestion” cause and decimal diagnostic value # n.

NOTES

1 If STE-Y issues a *clear request* packet as a result of an error condition in state p6, it should follow the actions described in Annex D.

2 The ERROR (p7) procedure is invoked if STE-Y receives a *call connected* packet in response to a *call request* packet from STE-Y requesting the *fast select* facility with restriction on response.

TABLE C.4/X.75

Action taken by STE-Y on receipt of packets specifying an assigned logical channel in a given state: reset

<table>
<tr><td rowspan="3">Packet received by STE-Y</td><td colspan="3">State of the interface as perceived by STE-Y</td></tr>
<tr><td colspan="3">Data transfer p4</td></tr>
<tr><td>Flow control
ready
d1</td><td>STE-X reset
request
d2</td><td>STE-Y reset
request
d3</td></tr>
<tr><td>Reset request</td><td>NORMAL
(d2)</td><td>DISCARD
(d2)</td><td>NORMAL
(d1)</td></tr>
<tr><td>Reset confirmation</td><td>ERROR
(d3)
27</td><td>ERROR
(d3)
28</td><td>NORMAL
(d1)</td></tr>
<tr><td>Data, interrupt or flow control</td><td>(See
Table C.5)</td><td>ERROR
(d3)
28</td><td>DISCARD
(d3)</td></tr>
<tr><td>Restart request or confirmation with bit 1 to 4 of octet 1 or bit 1 to 8 of octet 2 ≠ 0</td><td>ERROR
(d3)
41</td><td>ERROR (d3)
(see Note 1)
41</td><td rowspan="2">DISCARD
(d3)</td></tr>
<tr><td>Packet having a packet type identifier which is shorter than 1 octet or is incompatible with the ones defined in clause 4</td><td>ERROR
(d3)
38 or # 33</td><td>ERROR (d3)
(see Note 1)
38 or # 33</td></tr>
<tr><td>Invalid packet type on a permanent virtual circuit</td><td>ERROR
(d3)
35</td><td>ERROR (d3)
(see Note 1)
35</td><td></td></tr>
</table>

NORMAL The action taken by STE-Y follows the normal procedures as defined in clause 3 of the text (see Note 2).

DISCARD STE-Y discards the received packet and takes no subsequent action.

ERROR STE-Y discards the received packet and indicates resetting with “network congestion” cause and decimal diagnostic value # n.

NOTES

1 If STE-Y issues a *reset request* packet as a result of an error condition in state d2, it should follow the actions described in Annex D.

2 In the following error situations the STE will invoke the ERROR (d3) procedure: the received packet exceeds the maximum permitted length, is too short or (where detection of non-octet alignment is made at packet layer) is not octet aligned; diagnostic values # 39, # 38 and # 82 respectively are used.

TABLE C.5/X.75

Action taken by receipt of packets specifying an assigned logical channel in a given state: data, interrupt or flow control

Packet received by STE-Y	State of the interface as perceived by STE-Y			
	Flow control ready d1			
	Not interrupted i1	STE-X interrupt request i2	STE-Y interrupt request i3	STE-X and Y interrupt request i4
Interrupt	NORMAL (i2)	DISCARD (i2) or ERROR (d3) (see Note 1) # 44	NORMAL (i4)	DISCARD (i4) or ERROR (d3) (see Note 1) # 44
Interrupt confirmation	DISCARD (i1)	DISCARD (i2)	NORMAL (i1)	NORMAL (i2)
Data with out of sequence P(S) or P(S) outside of window	ERROR (d3) # 1	ERROR (d3) # 1	ERROR (d3) # 1	ERROR (d3) # 1
Data with M bit violation	ERROR (d3) # 103	ERROR (d3) # 103	ERROR (d3) # 103	ERROR (d3) # 103
Data with inconsistent Q bit setting	NORMAL (i1) or ERROR (d3) # 83 (see Note 3)	NORMAL (i2 or ERROR (d3) # 83 (see Note 3)	NORMAL (i3) or ERROR (d3) # 83 (see Note 3)	NORMAL (i4) or ERROR (d3) # 83 (see Note 3)
Data or flow control with invalid P(R)	ERROR (d3) # 2	ERROR (d3) # 2	ERROR (d3) # 2	ERROR (d3) # 2
A first data packet after entering state dl with P(S) ≠ 0	ERROR (d3) # 1	ERROR (d3) # 1	ERROR (d3) # 1	ERROR (d3) # 1
When modulo 128 numbering is used, a flow control or data packet with octet 4 shorter than 1 octet	ERROR (d3) # 38	ERROR (d3) # 38	ERROR (d3) # 38	ERROR (d3) # 38
Valid data or flow control	NORMAL (i1)	NORMAL (i2)	NORMAL (i3)	NORMAL (i4)

NORMAL The action taken by STE-Y follows the normal procedures as defined in clause 3 of the text (see Note 2).

DISCARD STE-Y discards the received packet and takes no subsequent action.

ERROR STE-Y discards the received packet and indicates reset with “network congestion” cause and decimal diagnostic value # n.

NOTES

1 According to 3.3.5 an STE receiving a further *interrupt* packet in the time between receiving one *interrupt* packet and transferring the interrupt confirmation may either discard this *interrupt* packet or reset the virtual call or the permanent virtual circuit.

2 In the following error situations the STE will invoke the ERROR (d3) procedure: the received packet exceeds the maximum permitted length, is too short or (where detection of non-octet alignment is made at packet layer) is not octet aligned; diagnostic values # 39, # 38 and # 82 respectively are used.

3 According to 3.3.4 if an STE detects that the value of the Q bit has changed within a packet sequence it may reset the virtual call or permanent virtual circuit.

Annex D

Actions taken by the STE on time-outs in the packet layer

(This annex forms an integral part of this Recommendation)

Under certain circumstances. the STE Y/X is required to respond to a packet from the STE X/Y within a stated maximum time. If any of these maximum times are exceeded, a time-out in the STE X/Y will initiate the actions summarized in Tables D.l and D.2. Therefore, this must be taken into account in the STE design.

TABLE D.l/X.75

STE X/Y time-outs (first time)

Time-out number	Time-out value	State of the logical channel	Started when	Normally terminated when	Actions to be taken the first time the time-out expires	
					Toward STE Y/X	Toward network
T30	180 sec.	r2/r3	STE X/Y issues a *restart request* packet	STE X/Y leaves the r2/r3 state (i.e., a *restart confirmation* or *restart request* packet is received)	STE X/Y signals a *restart request* packet (*network congestion*, # 52) again, and restarts time-out T30	For permanent virtual circuits, the STE signals a *reset request* packet (*network congestion*, # 52)
T31	200 sec.	p2/p3	STE X/Y issues a *call request* packet	STE X/Y leaves the p2/p3 state (e.g., a *call connected*, *clear request* or *call request* packet is received)	STE X/Y enters the p6/p7 state signalling a *clear request* packet (*network congestion*, # 49)	STE X/Y signals *a clear request* packet (*network congestion*, # 49)
T32	180 sec.	d2/d3	STE X/Y issues a *reset request* packet	STE X/Y leaves the d2/d3 state (e.g., a *reset confirmation* or *reset request* packet is received)	STE X/Y signals a *reset request* packet (*network congestion*, # 51) again and restarts time-out T32	STE X/Y signals *reset request* packet (*network congestion*, # 51)
T33	180 sec.	p6/p7	STE X/Y issues a *clear request* packet	STE X/Y leaves the p6/p7 state (e.g., a *clear confirmation* or *clear request* packet is received)	STE X/Y signals a *clear request* packet (*network congestion*, # 50) again, and restarts time-out T33	

TABLE D.2/X.75

STE X/Y time-outs (second time)

<table>
<tr><th rowspan="2">Time-out number</th><th colspan="2">Actions to be taken the second time the time-out expires</th></tr>
<tr><th>Toward STE X/Y</th><th>Toward network</th></tr>
<tr><td>T30</td><td>STE X/Y enters the r1 state
NOTE – Further actions may be initiated at higher level.</td><td>For permanent virtual circuits, STE X/Y signals a reset request packet (network congestion, # 52)</td></tr>
<tr><td>T31</td><td colspan="2">(Not possible; T31 is not restarted after it has expired)</td></tr>
<tr><td rowspan="2">T32</td><td>For virtual calls, STE X/Y enters the p6/p7 state signalling a clear request packet (network congestion, # 51)</td><td>For virtual calls, STE X/Y signals a clear request packet (network congestion, # 51)</td></tr>
<tr><td>For permanent virtual circuits. STE X/Y enters the d1 state</td><td>For permanent virtual circuits, STE X/Y signals a reset request packet (network congestion, # 51)</td></tr>
<tr><td>T33</td><td>STE X/Y enters the p1 state</td><td></td></tr>
</table>

Annex E

Coding of network generated diagnostic fields in X.75 clear, reset and restart packets

(This annex forms an integral part of this Recommendation)

TABLE E.1/X.75

(See Notes 1, 2, 3 and 9)

Diagnostics	Bits								Decimal
	8	7	6	5	4	3	2	1	
No additional information	0	0	0	0	0	0	0	0	0
Invalid P(S)	0	0	0	0	0	0	0	1	1
Invalid P(R)	0	0	0	0	0	0	1	0	2
	0	0	0	0	1	1	1	1	15
Packet type invalid	0	0	0	1	0	0	0	0	16
For state r1	0	0	0	1	0	0	0	1	17
For state r2	0	0	0	1	0	0	1	0	18
For state r3	0	0	0	1	0	0	1	1	19
For state p1	0	0	0	1	0	1	0	0	20
For state p2	0	0	0	1	0	1	0	1	21
For state p3	0	0	0	1	0	1	1	0	22
For state p4	0	0	0	1	0	1	1	1	23
For state p5	0	0	0	1	1	0	0	0	24
For state p6	0	0	0	1	1	0	0	1	25
For state p7	0	0	0	1	1	0	1	0	26
For state d1	0	0	0	1	1	0	1	1	27
For state d2	0	0	0	1	1	1	0	0	28
For state d3	0	0	0	1	1	1	0	1	29
	0	0	0	1	1	1	1	1	31
Packet not allowed	0	0	1	0	0	0	0	0	32
Unidentifiable packet	0	0	1	0	0	0	0	1	33
Call on one way logical channel (Note 4)	0	0	1	0	0	0	1	0	34
Invalid packet type on a permanent virtual circuit	0	0	1	0	0	0	1	1	35
Packet on unassigned logical channel	0	0	1	0	0	1	0	0	36
Reject not subscribed to (Note 4)	0	0	1	0	0	1	0	1	37
Packet too short	0	0	1	0	0	1	1	0	38
Packet too long	0	0	1	0	0	1	1	1	39
Invalid general format identifier	0	0	1	0	1	0	0	0	40
Restart with non-zero in bits 1-4, 9-16	0	0	1	0	1	0	0	1	41
Packet type not compatible with facility/utility (Note 5)	0	0	1	0	1	0	1	0	42
Unauthorized interrupt confirmation	0	0	1	0	1	0	1	1	43
Unauthorized interrupt	0	0	1	0	1	1	0	0	44
Unauthorized reject (Note 4)	0	0	1	0	1	1	0	1	45
	0	0	1	0	1	1	1	1	47

TABLE E.1/X.75 *(continued)*

Diagnostics	Bits								Decimal
	8	7	6	5	4	3	2	1	
Time expired	0	0	1	1	0	0	0	0	48
For incoming call/call request (Note 6)	0	0	1	1	0	0	0	1	49
For clear indication/request (Note 6)	0	0	1	1	0	0	1	0	50
For reset indication/request (Note 6)	0	0	1	1	0	0	1	1	51
For restart indication/request (Note 6)	0	0	1	1	0	1	0	0	52
	0	0	1	1	1	1	1	1	63
Call set-up or clearing problem	0	1	0	0	0	0	0	0	64
Facility/utility code not allowed (Note 5)	0	1	0	0	0	0	0	1	65
Facility/utility parameter not allowed (Note 5)	0	1	0	0	0	0	1	0	66
Invalid called address	0	1	0	0	0	0	1	1	67
Invalid calling address	0	1	0	0	0	1	0	0	68
Invalid facility length	0	1	0	0	0	1	0	1	69
Incoming call barred	0	1	0	0	0	1	1	0	70
No logical channel available	0	1	0	0	0	1	1	1	71
Call collision	0	1	0	0	1	0	0	0	72
Duplicate facility/utility requested (Note 5)	0	1	0	0	1	0	0	1	73
Non-zero address length	0	1	0	0	1	0	1	0	74
Non-zero facility length	0	1	0	0	1	0	1	1	75
Facility/utility not provided when expected (Note 5)	0	1	0	0	1	1	0	0	76
Invalid CCITT-specified DTE facility	0	1	0	0	1	1	0	1	77
Maximum number of call redirections or call deflections exceeded	0	1	0	0	1	1	1	0	78
	0	1	0	0	1	1	1	0	78
Miscellaneous	0	1	0	1	0	0	0	0	80
Improper cause code from DTE/STE (Note 7)	0	1	0	1	0	0	0	1	81
Octet non-aligned	0	1	0	1	0	0	1	0	82
Inconsistent Q bit setting	0	1	0	1	0	0	1	1	83
NUI problem	0	1	0	1	0	1	0	0	84
	0	1	0	1	1	1	1	1	95
Inter-network call set-up or clearing problem	0	1	1	0	0	0	0	0	96
Unknown calling DNIC	0	1	1	0	0	0	0	1	97
TNIC mismatch	0	1	1	0	0	0	1	0	98
Call identifier mismatch	0	1	1	0	0	0	1	1	99
Negotiation error in utility parameter value	0	1	1	0	0	1	0	0	100
Invalid utility length	0	1	1	0	0	1	0	1	101
Non-zero utility length	0	1	1	0	0	1	1	0	102
M bit violation	0	1	1	0	0	1	1	1	103
	0	1	1	0	1	1	1	1	111

TABLE E.1/X.75 *(end)*

Diagnostics	Bits								Decimal
	8	7	6	5	4	3	2	1	
Inter network problem	0	1	1	1	0	0	0	0	112
Remote network problem	0	1	1	1	0	0	0	1	113
Inter-network protocol problem	0	1	1	1	0	0	1	0	114
Inter-network link out of order	0	1	1	1	0	0	1	1	115
Inter-network link busy	0	1	1	1	0	1	0	0	116
Transit network facility problem	0	1	1	1	0	1	0	1	117
Remote network facility problem	0	1	1	1	0	1	1	0	118
Inter-network routing problem	0	1	1	1	0	1	1	1	119
Temporary routing problem	0	1	1	1	1	0	0	0	120
Unknown called DNIC	0	1	1	1	1	0	0	1	121
Maintenance action	0	1	1	1	1	0	1	0	122
	0	1	1	1	1	1	1	1	127
Reserved for network specific diagnostic information (Note 8)	1	0	0	0	0	0	0	0	128
	1	1	1	1	1	1	1	1	255

NOTES

1 Not all diagnostic codes need apply to a specific network, but those used are coded as in the table.

2 A given diagnostic need not apply to all packet types (i.e. *reset request*. *clear request* and *restart request* packets).

3 The first diagnostic in each grouping is a generic diagnostic and can be used in place of the more specific diagnostics within the grouping. The decimal 0 diagnostic code can be used in situations where no additional information is available.

4 Only generated at a user interface (see Recommendation X.25).

5 When associated with the cause "Network congestion", this indicates a utility problem; when associated with any other valid cause (see Tables 13, 15 and 17) this indicates a facility problem at a user interface.

6 When associated with the cause "Network congestion", this indicates an X.75 packet timer problem; when associated with any other valid cause (see Tables 13, 15 and 17) this indicates a packet timer problem at a user interface.

7 When associated with the cause "Network congestion", this indicates an invalid cause detected on an X.75 link; when associated with any other valid cause (see Tables 13, 15 and 17) this indicates an invalid cause detected at a user interface.

8 When the associated cause is "Network congestion". diagnostic codes in this range may by bilateral agreement between Administrations, be transferred across an X.75 link. However, the receiving network will alter such values, as described in 4.2.3.2, 4.4.3.2 or 4.5.1.2 as appropriate, before passing them to another network or across a user interface.

9 When the associated cause is "Network congestion", diagnostic codes in the range 1 to 111 will be altered by the receiving network, as described in 4.2.3.2 , 4.4.3.2 or 4.5.1.2 as appropriate, before passing them to another network or across a user interface.

Annex F

Association of error conditions with cause and diagnostic codes

(This annex forms an integral part of this Recommendation)

a) Call request packet

	Error condition	Cause	Specific diagnostics (see Note 3 of Annex E)
1	Not octet aligned packet (where detection of non-octet alignment is made at packet level if implemented, see clause 3)	Network congestion	# 82
2.	Address contains a non-BCD digit	Network congestion	# 67, 68
3.	Address less than four digits	Network congestion	# 67, 68
4.	Call set-up/clearing packet exceeds 323 octets	Network congestion	# 39
5.	No combination of utilities could equal utility length	Network congestion	# 101
6.	Facility or utility length larger than remainder of packet	Network congestion	# 38
7.	Utility value conflicts (e.g., a particular combination not supported)	Network congestion	# 66
8.	Utility code not allowed	Network congestion	# 65
9.	Utility value not allowed or invalid	Network congestion	# 66
10.	Utility expected and not provided	Network congestion	# 76
11.	Packet too short	Network congestion	# 38
12.	Address length larger than remainder of packet	Network congestion	# 38
13.	Call user data larger than 16, or 128 octets in case of fast select facility	Network congestion	# 39
14.	Class coding of the utility corresponding to a length of parameter larger than remainder of packet	Network congestion	# 101
15.	Utility code (except TNIC and ROA) repeated	Network congestion	# 73
16.	Duplicate TNIC	Network congestion	# 66
17.	Unknown calling network identification	Network congestion	# 97
18.	Unknown number	Not obtainable	# 67
19.	Incoming call barred	Access barred	# 70
20.	Closed user group protection	Access barred	# 65

Error condition	Cause	Specific diagnostics (see Note 3 of Annex E)
21. Reverse charging rejected	Reverse charging acceptance not subscribed	# 0
22. Fast select rejected	Fast select acceptance not subscribed	# 0
23. National address smaller than national address format permits	Not obtainable	# 67, 68
24. National address larger than national address format permits	Not obtainable	# 67, 68
25. Called DTE out of order	Out of order	# 0 # greater than 127
26. No logical channel available	Number busy	# 71
27. Call collision	Number busy	# 71, 72
28. The remote DTE/DCE interface does not support a function or a facility request	Incompatible destination	# 0
29. Procedure error at the remote DTE/DCE interface	Remote procedure error	(see Annex E)
30. Network congestion or fault condition within the network	Network congestion	# 0 # greater than 127 (see Note 8 to Annex E)
31. Planned maintenance activity within the network	Network congestion	# 122
32. Network fault condition detected other than at the local STE X/Y interface	Network congestion	# 113
33. X.75 protocol error detected other than at the local STE X/Y interface	Network congestion	# 114
34. No inter-Administration service agreement is recorded for calls from the calling network to the called network	Access barred	# 119
35. No inter-Administration service agreement is recorded for calls from the calling network to the called network using the routing indicated	Access barred	# 119
36. The inter-Administration service agreement does not permit calls using the requested facility(ies) from the calling network to the called network	Incompatible destination	# 118

Error condition	Cause	Specific diagnostics (see Note 3 of Annex E)
37. The routing process is unable to determine any suitable outgoing link for the called network	Not obtainable	# 121
38. The routing process is unable to determine a suitable outgoing link with a free logical channel	Network congestion	# 116
39. Call collision is detected on the selected outgoing link	Network congestion	# 116
40. The routing indicated in the received *call request* packet is too long for an overall routing conforming to X.110 to be provided (e.g., because alternative routing has already been used)	Network congestion	# 120
41. The routing indicated in the received *call request* packet cannot be extended to provide an overall routing in conformance with X.110 (e.g., because the prior use of alternative routing means that a circular routing would be formed)	Network congestion	# 120
42. Each of the suitable outgoing links determined by the routing process is subject to an unplanned outage	Network congestion	# 115
43. The routing process is unable to determine a suitable operational outgoing link supporting the requested facility(ies)	Network congestion	# 117
44. The routing process is unable to determine a suitable operational outgoing link supporting the parameter value of a requested facility	Network congestion	# 117
45. None of the suitable outgoing links determined by the routing process is operational, and at least one is subject to a planned outage for essential maintenance	Network congestion	# 122
46. Requested ROA out of order	ROA problem	# 0
47. Requested ROA invalid or not supported	ROA problem	# 119
48. NUI utility value invalid/unsupported or NUI utility required but absent	Access barred	# 84
49. Excessive number of call redirections or deflections detected for call	Access barred	# 78
NOTE – Error conditions 18 to 29 are examples for problems related to the destination network.		

b) Call connected packet

Error condition		Cause	Specific diagnostics (see Note 3 of Annex E)
1.	Not octet aligned packet (where detection of non-octet alignment is made at packet level if implemented; see clause 3)	Network congestion	# 82
2.	Address contains a non-BCD digit	Network congestion	# 67, 68
3.	Address less than four digits	Network congestion	# 67, 68
4.	Call set-up/clearing packet exceeds 323 octets	Network congestion	# 39
5.	No combination of utilities could equal utility length	Network congestion	# 101
6.	Facility or utility length larger than remainder of packet	Network congestion	# 38
7.	Utility value conflicts (e.g., a particular combination not supported)	Network congestion	# 66
8.	Utility code not allowed	Network congestion	# 65
9.	Utility value not allowed or invalid	Network congestion	# 66
10.	Utility expected and not provided	Network congestion	# 76
11.	Packet too short	Network congestion	# 38
12.	Address length larger than remainder of packet	Network congestion	# 38
13.	Call user data larger than 128 octets in case of *fast select* facility	Network congestion	# 39
14.	Call user data present (if *fast select* facility not requested)	Network congestion	# 39
15.	Class coding of the utility corresponding to a length of parameter larger than remainder of packet	Network congestion	# 101
16.	Utility code (except TNIC and ROA) repeated	Network congestion	# 73
17.	Unknown calling network identification	Network congestion	# 97
18.	Duplicate TNIC	Network congestion	# 66
19.	The *call request* packet indicated *fast select* with restriction on response	Network congestion	# 42
20.	Call identifier mismatch	Network congestion	# 99
21.	TNIC mismatch	Network congestion	# 98
22.	Negotiation error in utility parameter value	Network congestion	# 100
23.	NUI utility value invalid/unsupported or NUI utility required but absent	Access barred	# 84

c) **Clear request packet**

Error condition	Cause	Specific diagnostics (see Note3 of Annex E)
1. Not octet aligned packet (where detection of non-octet alignment is made at packet level if implemented; see clause 3)	Network congestion	# 82
2. Packet too short	Network congestion	# 38
3. Packet too long	Network congestion	# 39
4. Address length fields incorrectly set to non-zero	Network congestion	# 74
5. Utility length field incorrectly set to non-zero	Network congestion	# 102
6. Call user data larger than 128 in case of *fast select* facility (if *fast select* facility requested)	Network congestion	# 39
7. Call user data present (if *fast select* facility not requested)	Network congestion	# 39
8. Improper cause code from STE (if implemented; see 4.2.3.1)	Network congestion	# 81
9. Call set-up/clearing packet exceeds 323 octets	Network congestion	# 39

d) **Clear confirmation packet**

Error condition	Cause	Specific diagnostics (see Note 3 of Annex E)
1. Not octet aligned packet (where detection of non-octet alignment is made at packet level if implemented; see clause 3)	Network congestion	# 82
2. Packet length larger than 3 octets	Network congestion	# 39

Appendix I

Examples of multilink resetting procedures

(This appendix does not form an integral part of this Recommendation)

I.1 Introduction

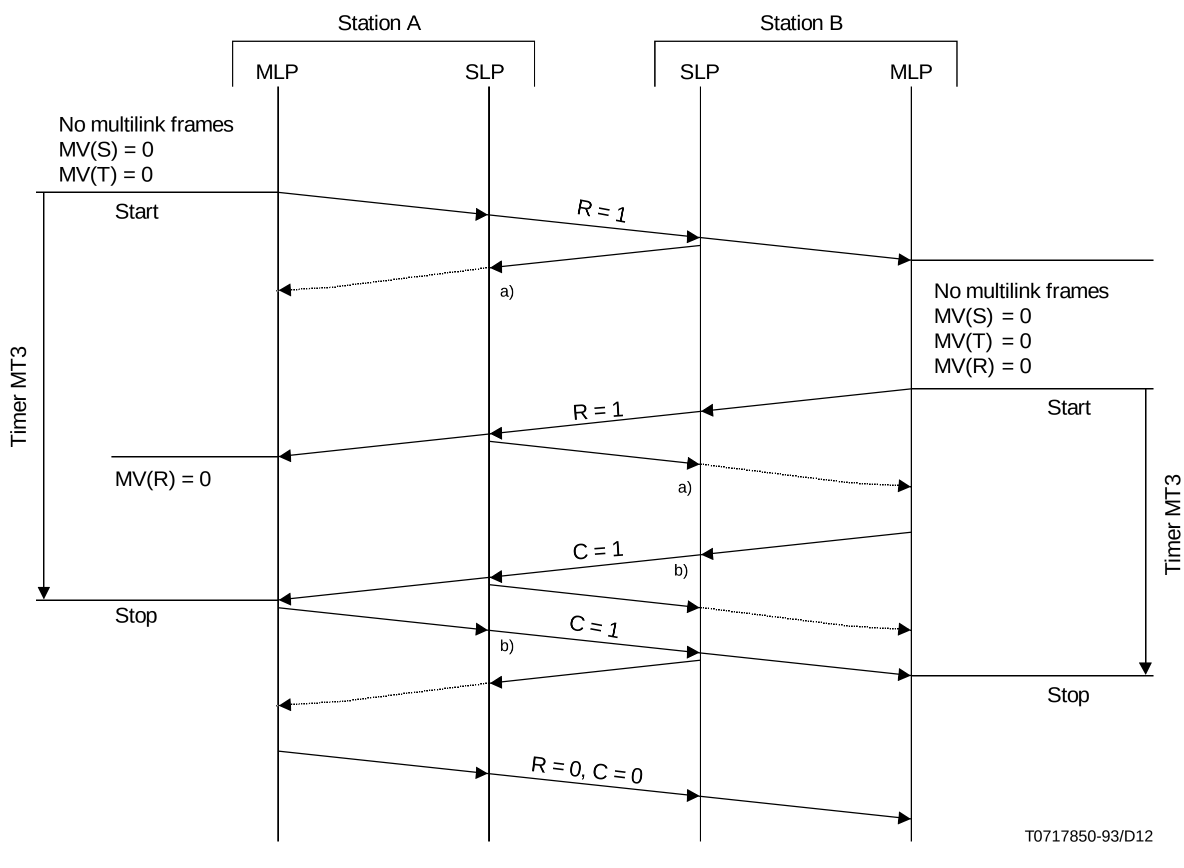
The following examples illustrate application of the multilink resetting procedures is the case of:

a) MLP reset initiated by a single STE; and

b) MLP reset initiated by both STEs simultaneously.

I.2 MLP reset initiated by a single STE

See Figure I.2.



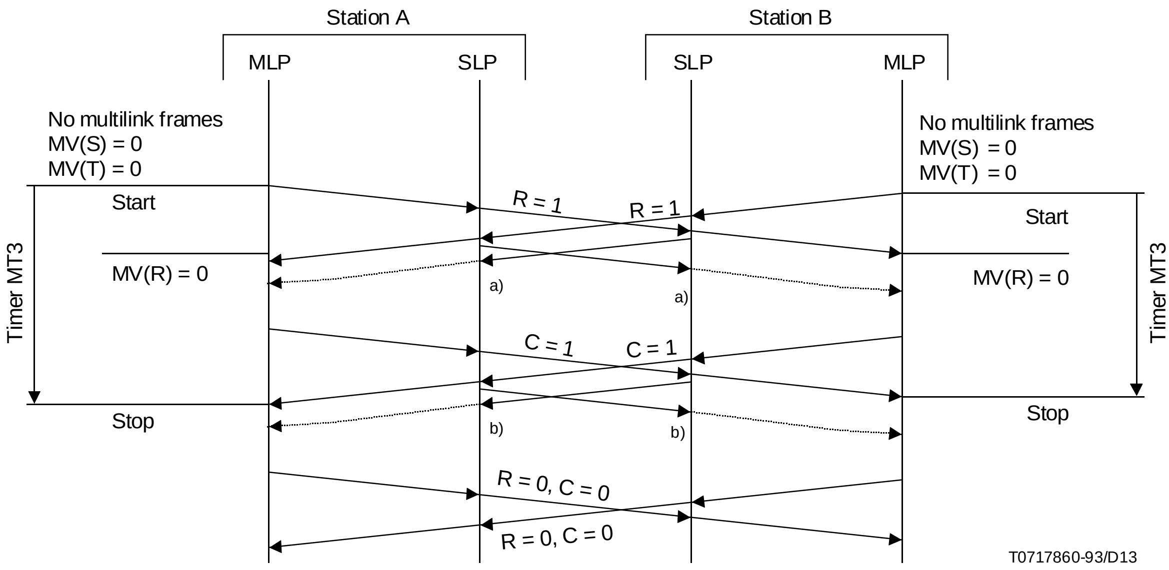
a) The SLP frame that acknowledges delivery of the multilink frame with R = 1.

b) The SLP frame that acknowledges delivery of the multilink frame with C = 1.

FIGURE I.1/X.75

I.3 MLP reset initiated by both STEs simultaneously

See Figure I.2.



a) The SLP frame that acknowledges delivery of the multilink frame with R = 1.
b) The SLP frame that acknowledges delivery of the multilink frame with C = 1.

FIGURE I.2/X.75

Appendix II

Additional information on data signalling rates higher than 64 kbit/s

(This appendix does not form an integral part of this Recommendation)

II.1. Use of time slot 0 to 2 Mbit links

Time slot 0 can be used to detect the faults listed hereafter. The actions to be taken after fault detection are indicated.

II.1.1 Loss of frame alignment

The loss of frame alignment is defined in 4.1.1/G.706. At least three consecutive incorrect frame alignment signals should be received. The recovery of frame alignment is specified in 4.1.2/G.706.

In case of loss of frame alignment remote alarm indication should be sent in the opposite direction using bit 3 of time slot 0 of the frame not containing the frame alignment signal as long as the recovery of the frame alignment has not been reached. The transmission of data in the opposite direction should be stopped at the end of the ongoing frame and replaced by all l's. Eventually the data stream to be delivered to the layer 2 entity could be forced to all 1's.

II.1.2 Alarm indication signal (AIS)

AIS is defined as the receipt of all bits with value 1, including the bits of time slot 0.

Transmission line termination equipment normally monitors violations of the line code (HDB3). In case of an excessive number of such violations the Transmission Line Termination equipment generates AIS.

In case of AIS remote alarm indication should be sent in the opposite direction using bit 3 of time slot 0 of the frame not containing the frame alignment signal during this error condition. The transmission of data in the opposite direction should be stopped at the end of the ongoing frame and replaced by all 1's.

II.1.3 Excessive error ratio in frame alignment

Excessive error ratio in frame alignment is defined in 4.1.6/G.732.

In this case remote alarm indication should be sent in the opposite direction using bit 3 of time slot 0 of the frame not containing the frame alignment signal during this error condition. The transmission of data in the opposite direction should be stopped at the end of the ongoing frame and replaced by all 1's. Eventually the data stream to be delivered to the layer 2 entity could be forced to all 1's.

II.1.4 Remote alarm indication

Remote alarm indication is received if bit 3 of time slot 0 of a frame not containing the frame alignment signal has the value 1.

In this case the transmission of data in the opposite direction should be stopped at the end of the ongoing frame and replaced by all 1's.

II.1.5 CRC failure

CRC failure is defined in 2.3.3/G.704.

CRC multiframe alignment achievement should be used as verification of the frame alignment according to 4.2/G.706.

If the number of received sub-multiframes with a faulty CRC exceeds 915 in one second then loss of frame alignment is invoked.

For each sub-multiframe received with a CRC failure a frame with E = 0 should be sent in the other direction.

The count of the number of received sub-multiframes with a faulty CRC and/or the received multiframes with the E-bit = 0 could be used for performance monitoring.

Thresholds and actions are to be further studied.

II.1.6 Broken line

An open input line (no voltage) differs from AIS since AIS is still coded in HDB3 resulting in alternate positive and negative voltages.

In case of broken line remote alarm indication should be sent in the opposite direction using bit 3 of time slot 0 of the frame not containing the frame alignment signal during this error condition. The transmission of data in the opposite direction should be stopped at the end of the ongoing frame and replaced by all 1's. Eventually the data stream to be delivered to the layer 2 entity could be forced to all 1's.

An alarm destined for the network operator should be generated in case of a continued error condition. The criteria (frequency, duration) for this alarm generation are network dependent.

The generation of an excessive number of alarms due to repeated error conditions over a short time period should be avoided.

The criteria (frequency, duration) for each of the error conditions resulting in maintenance actions should be bilaterally agreed between network operators.

The maintenance actions should use the possibilities of activating loops in order to isolate the faulty element in the 2 Mbit/s link.

II.2. Guidelines for data signalling rates higher than 64 kbit/s in order to support high throughput

- No use of satellite links (G1 links) for small packet sizes (e.g., 128 octets).
- Use of frame-level modulo 128 (*k* between 60 and 127).
- The bit error rate of the link should be better than 10^{-5}.
- The use of RNR frame should be avoided.

Appendix III

Guidelines for transmission over channels with long round-trip delay and/or transmission rates higher than 64 kbit/s

(This appendix does not form an integral part of this Recommendation)

III.1 Preamble

The default parameters of X.75, viz data link layer modulo, frame size and window size (k) value, and packet layer modulo, packet size and window size are not optimized for operation over connections in which a long round-trip delay will be encountered, such as cables with long delays and satellite links, nor for transmissions rates higher than 64 kbit/s.

NOTE – The round-trip delay is the time that elapses between sending the first bit of an I frame and receiving the last bit of the corresponding acknowledgement frame. Hence, round-trip delay is dependent on the transmission rate frame size, the propagation delay of the channel and the queuing processing delay of the STES.

This appendix provides guidelines for the appropriate selection of parameters in these cases.

III.2 Common guidelines

To make maximum use of channels with long round-trip delay and/or high bandwidth, it is necessary to ensure that a sufficient number of octets are transmitted. This number is a function, first, of the transmission rate (R) and round-trip delay (D) and, second, of other factors such as bit error ratio (BER). Annex A/X.135 and Annex B/X.138 provide a list of factors to be specified in reporting throughput performance.

Based on the primary factors, the number of octets is:

$$x\,(\text{octets}) = \frac{\text{D}\,(\text{sec}) \ * \ \text{R}\,(\text{bit/s})}{8}$$

Therefore, approximately x octets, depending on the secondary factors, are needed. From the value of x, the following expressions provide the minimum requirements for selection of maximum frame size (NI), maximum number of outstanding I frames (k), and maximum retransmission delay (TI) as a function of x and D:

$$\text{N1}(\text{octets}) \ * \ k = x$$
$$\text{and T1} > \text{D}$$

For a given k, N1 is directly derived. However, not all frames and layer 3 packets will be of maximum size. Derivation of an optimal value of k in such cases is beyond the scope of this appendix (the distribution of various sizes of frames/packets being STE).

III.3 Guidelines for channels with long round-trip delays operating at 64 kbit/s

For the data link layer operating over connections with a maximum round nip delay of 600 ms (which includes one satellite hop), the modulo 8 frame numbering may be used, but a frame size of at least 1024 octets is necessary to maximize efficiency. If a smaller frame is to be used, it is necessary to use modulo 128.

Assuming modulo 128, layer 2 windows (k) can be derived from the allowable maximum packet sizes (maximum frame sizes, N1, are derived from the maximum packet sizes with the addition of 11 octets, for the packet overhead of 4 octets and frame overhead of 7 octets). These are shown in Table III.1 below:

III.4 Guidelines for circuits operating at 1920 kbit/s

For X.75 terrestrial circuits with transmission rates of 1920 kbit/s and round-trip delay in the order of 1 ms, modulo 8 is considered sufficient. For longer round-trip delays operating at 1920 kbit/s, assuming modulo 128, the following parameters are suggested:

a) for cables with nominal delays (D ~ 10 ms), see Table III.2;

b) for cables with long delays (D ~ 120 ms), see Table III.3. Appropriate *k* values for different packet sizes are shown;

c) for satellite links (D ~ 600 ms), see Table III.4. Appropriate *k* values for different packet sizes are shown.

TABLE III.1/X.75

Layer 2 window (*k*) – 64 kbit/s – round-trip delay of 600 ms

Packet Data Field Size (Octets)	Frame Size N1 with Overhead (Octets)	*k*
128	139	35
256	267	18
512	523	10
1024	1035	5
2048	2059	3
4096	4107	2

TABLE III.2/X.75

Layer 2 window (*k*) – 1920 kbit/s – round-trip delay of 10 ms

Packet Data Field Size (Octets)	Frame Size N1with Overhead (Octets)	*k*
128	139	18
256	267	9
512	523	5
1024	1035	3
2048	2059	2

TABLE III.3/X.75

Layer 2 window (*k*) – 1920 kbit/s – round-trip delay of 120 ms

Packet Data Field Size (Octets)	Frame Size N1 with Overhead (Octets)	*k*
256	267	108
512	523	56
1024	1035	28
2048	2059	14
4096	4107	8

TABLE III.4/X.75

Layer 2 window (*k*) – 1920 kbit/s – round-trip delay of 600 ms

Packet Data Field Size (Octets)	Frame Size N1 with Overhead (Octets)	*k*
2048	2059	70
4096	4107	36